Economic Review

May/June 1993
Volume 78, Number 3

Federal Reserve Bank of Atlanta

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Economic
Review

May/June 1993, Volume 78, Number 3

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The *Economic Review* of the Federal Reserve Bank of Atlanta presents analysis of economic and financial topics relevant to Federal Reserve policy. In a format accessible to the nonspecialist, the publication reflects the work of the Research Department. It is edited, designed, produced, and distributed through the Public Affairs Department.

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Along with the increasing development of international goods and capital markets, countries have shown growing interest in crafting joint macroeconomic policies. This article examines some of these policy coordination efforts, particularly those the authors classify as "incomplete," which involve countries agreeing to use policies to achieve some common objective but do not require relinquishing all autonomy to a central authority in the design of macropolicies.

The authors also review some of the theoretical research on the subject, which suggests that economies linked by capital and service markets—open economies—generate externalities for each other. Countries choosing policies independently cannot fully incorporate into their decision-making processes the effects of their choices on the world community. According to the literature reviewed, only full coordination of macropolicies results in the internalization of policy effects and leads to improved welfare worldwide.

The authors emphasize that currently, however, most coordination efforts are incomplete. At the same time, only full coordination is able to eliminate the transmission of negative externalities, and decisionmakers are therefore tempted to try to reconcile mutually exclusive policy approaches.

The determinants of interest rates across the spectrum of bond maturities are of keen interest to borrowers and lenders as well as to economists. The inflation forecasts implicit in interest rates carry strong credibility with most market observers because interest rates in part represent bets backed by wealth rather than casual forecasts with little at stake. The trouble is that interest rates are influenced by more than just market expectations of inflation; other factors cloud the inflation signal perceived in the term structure or relationship between interest rates of various maturities.

Despite the complexity of interest rates, people who want to gauge inflation expectations turn to the yield curve. This article discusses key research studying the information on inflation contained in the nominal term structure of interest rates. The current evidence suggests that the yield curve does indeed give useful forecasts of inflation, especially at longer-term horizons, but much still needs to be learned about the various factors that influence nominal rates.

International Policy Coordination: Can We Have Our Cake and Eat It Too?

Marco Espinosa and Chong K. Yip

Recent events in European financial markets—in particular, Britain's and Italy's (at least temporary) departure from the exchange rate mechanism of the European monetary system, the French and Danish referendum votes on European union, as well as the emphasis on coordination stressed at the recent G-7 meetings—have generated a wave of headlines and have focused attention on the various ways in which macroeconomic policies are coordinated internationally. When a country's economy has no links with other economies—when an economy is "closed"—the fiscal or monetary policy behavior of other countries is irrelevant. However, when economies are linked by capital and services markets—that is, are "open"—policy decisions at home may have an impact abroad and vice versa. As the world is becoming increasingly integrated in trade and financial markets, economic events in one country inevitably have a bigger impact on other countries. Under global capital markets, for example, most countries have access to the same pool of world savings, and individual governments' borrowing and lending activities affect interest rates—and consequently, economic activity—worldwide. For this reason, the U.S. government budget deficit has been broadly blamed for the high worldwide interest rates that characterized the 1980s, and the "high" interest rates set by Germany's Bundesbank and the recent "caution" of the Bank of Japan have recently been held responsible for retarding economic growth in Europe, and perhaps worldwide.

As the development of international goods and capital markets has progressed to a degree unseen during the 1960s or 1970s, countries have shown increasing interest in crafting and adopting joint macropolicies or participating in international coordination efforts—at least implicitly as a means

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of ameliorating the transmission of negative policy-spillover effects—and a significant body of research has focused on designing models to analyze the impacts of such efforts. Perhaps the first question to be addressed is that of why countries do not simply move toward a world consisting exclusively of closed economies that would not be susceptible to the negative effects that might be transmitted across countries. Implicit in international coordination efforts is the notion that the positive effects of market integration outweigh its potential negative effects across countries and that most of the potentially undesirable effects can in fact be eliminated or at least drastically reduced with the right coordination scheme. Although, as the discussion makes clear later, there is no such thing as the "right" coordination scheme, the point of departure for discussion is the assumption that integration is worth pursuing.

A number of theoretical perspectives, each with its own policy implications, have found favor with policymakers over time. The purpose of this article is to examine some of the various macroeconomic policy efforts, particularly for the ways in which they attempt to minimize the intercountry transmission of negative spillover effects of policy decisions. The discussion also considers some of the theoretical research on this subject.

Recent Coordination Efforts

Efforts to coordinate macroeconomic policies are not new. For example, during the Bretton Woods era (1944-73), a degree of policy coordination was embodied in the system of fixed exchange rates against the U.S. dollar, which was then tied to gold. In the beginning the Bretton Woods agreement allowed currency exchange rates of member countries to vary 1 percent against the U.S. dollar, which in turn was pegged to gold at a fixed rate—$35 per ounce. By agreeing to fix exchange rates, the monetary authorities involved committed their countries, unconditionally, to trade foreign and domestic currencies at certain exchange rates in the foreign exchange market and thus to modify their domestic money supplies to achieve these rates. Partly because the agreement restricted to some degree the monetary policies of the forty-four countries participating, the Bretton Woods system broke down in the early 1970s.

Efforts to coordinate policies have continued, however. A more recent example of exchange rate coordination is the Plaza Accord of 1985, established between the G-5 countries (the group of five leading industrial countries—France, Japan, the United States, the United Kingdom, and West Germany). Through the early 1980s, the dollar had appreciated steadily against major currencies, and by December 1984 the dollar exchange rates against the German mark and Japanese yen were 3.1 and 247.96, respectively. Along with the strong dollar came large U.S. trade deficits as Americans imported more and exported less. Policymakers viewed these developments as alarming and in need of reversal. The Plaza Accord provided multilateral support for reducing the foreign exchange value of the dollar, with the purpose of further reducing the U.S. current account deficit.[1]

Policy Coordination in Europe. Because half of European trade occurs between European countries, reducing exchange rate volatility has been a major consideration in coordination efforts. The assumption has been that high volatility of exchange rates makes it hard to predict the terms of trade (the relative prices of imports over exports), with consequent costly efficiency losses.[2] Some of the first attempts at coordinating exchange rates in Europe date back to the Joint Float agreement of 1972. This agreement called for its members to hold their currencies' bilateral exchange rates to a 2.5 percent variation. Although the origins of the EMS proposal can be traced to the 1957 Treaty of Rome, which founded the European Community, the Joint Float Agreement provided the working foundations of the European Monetary System (EMS) as it originated in 1979.

Since 1979, EMS exchange rate coordination efforts have been overseen by the exchange rate mechanism (ERM). The ERM calls for the exchange rates in each member country to vary no more than 2.25 percent from its bilateral central rate. To achieve this goal, central banks are willing to intervene in the exchange rate market buying and selling their currencies.[3]

Coordination efforts such as those discussed above can be classified as "incomplete," in the sense that the countries involved in these efforts agree to use their macroeconomic policies to achieve a common objective—a fixed exchange rate or an exchange rate band. If the goal is achieved, the member countries may realize efficiency gains as a result of the reduced exchange rate volatility and increased volume of trade. However, other than taking actions necessary to achieve the exchange rate objective, the participating countries are free to use their macroeconomic policies as they see fit. Clearly, countries involved in such exchange rate coordination efforts do not relinquish to a central authority all autonomy in macropolicy decisions. At the same time—and in fact because countries retain considerable autonomy—these coordination arrangements do not eliminate negative spillovers across countries. Some countries have therefore pursued more comprehensive coordination commitments that would ameliorate the transmission of negative macroeconomic policy spillovers. As evidence of this trend, the stated goals of the EMS have evolved into an economic convergence of its members as a means of eventually achieving monetary union, and the ERM is seen as an intermediate step in that direction. Unlike the coordination efforts discussed earlier, this proposed union supposedly would have an independent European Central Bank (ECB) and an associated European System of Central Banks (ESCB) overseeing implementation of the common monetary policy. Article 7 of the Maastricht Treaty protocol (1992), for example, states that "neither the ECB nor a national Central Bank, nor any member of their decision-making bodies shall seek nor take instructions from EC institutions or member governments." In fact, member governments would relinquish their autonomy in setting monetary policy to the independent ECB and ESCB. This type of coordination is referred to here as "complete."

The Maastricht Treaty, however, does not stop at the prospect of a unified monetary policy with a single currency. Some of the stated goals of the economic community allude to a "deeper integration into a virtual federal Europe." Such statements have inspired several studies that try to establish a parallel between the envisioned European economic union and the United States' complete de facto coordination agreement among its member states (see, for example, Paul Van Rompuy, Filip Abraham, and Dirk Heremans 1991). As envisioned by these authors, EMU members would function much like states of the United States, not only giving up sovereignty over seignorage (revenue raised by printing money) as a means to finance government deficits but allowing for complete mobility of all resources across member countries and the creation of a supernational government actively involved in all aspects of the community's economy, with individual country governments playing a subsidiary role. As Ralph C. Bryant has commented, such federalism issues are "well beyond the domains of 'coordination'" (1993). This discussion concentrates instead on issues related to coordination as Bryant has defined them: "Coordination goes further than mutual recognition in focusing on cross-border spillovers and 'arbitrage pressures' eroding the differences among national economies and policies. And coordination is more ambitious in promoting intergovernmental cooperation to deal with them. Coordination involves jointly designed mutual adjustments of national policies (commitments about time paths of policy instruments, not merely aspirations about time paths . . .)" (1993, 11).

As will be discussed in more detail later, only complete coordination agreements effectively eliminate the transmission of policy effects across countries, but they hinge on a country's relinquishment of autonomy in choosing policy. The distinction between complete and incomplete coordination is a crucial one because some policymakers and analysts often express the belief that countries can reap the benefits of a complete coordination arrangement while committing only to incomplete coordination—that it is possible to have one's cake and eat it too.[4]

This trade-off between the loss of policy autonomy and gains from eliminating negative spillovers may help explain why a complete coordination effort among countries seems so elusive and may ultimately be impossible to attain. In fact, the European "currency crisis" of September 1992 is a reminder of other failed coordination efforts and of the apparent fragility that surrounds the process. However, the emergence of a two-tier approach to coordination in Europe, with some countries firmly committed to EMU while others lag, illustrates the belief that coordination of macropolicies is considered beneficial and should not be abandoned.[5]

An Economic Modeling Perspective

To help understand the benefits and possible costs of policy coordination, economists have developed coordination models. While they are in general too simple to capture fully the complex features of coordination, these models shed valuable light on some of the major issues that may inhibit joint policy schemes.

Externalities. The "invisible-hand" principle of Adam Smith, familiar to any beginning economics student, states that the best way to promote social well-being is to allow everyone to pursue his or her own interest. It is also well known, however, that the principle may fail under the presence of what economists call "externalities." The most often cited example of negative externalities is that of a plant discharging polluted water into a river that is a town's only water source. Clearly, the sole pursuit of what the plant considers in its own best interest does not promote the welfare of the whole society; there are quite different private and social costs at stake.

In general in such situations, certain policies may restore efficiency by creating appropriate incentives for firms or other economic actors to achieve, on balance, what is best for the society as a whole. For example, in the case involving water pollution a pollution-control policy could be established: having to pay a fee every time waste is dumped would help polluters realize that natural resources they use are not "free." The idea is that they would then "internalize" this cost in their decision-making process and have incentives to look for alternatives to dumping, such as investing in cleaner technologies. Such a policy can be achieved, however, only if there is a central authority to enforce it.

It may be helpful to think of individual countries as analogous to the residents of the town affected by water pollution. To avoid negative spillovers across countries, coordination of macroeconomic policies may be desirable for the well-being of the world economy.[6] This line of thinking characterizes several of the formal attempts to study international interdependencies.

Open-Economy Macroeconomics

John M. Fleming (1962) and Robert A. Mundell (1963) set the foundation for the formal analysis of international macroeconomic policy coordination.[7] They analyzed the feedback of monetary and fiscal policies between two countries. Their models consist of goods and asset demand functions (including money) in the Keynesian tradition. National expenditures—consumption and investment—are assumed to depend on domestic output and the real (inflation-adjusted) rate of interest while net exports depend on income at home (imports) and abroad (exports) as well as the real exchange rate. For instance, a rise in German income increases Britain's exports because Germans can afford to buy more goods, including imported goods. Another assumption is that public demand for money is a function of income and interest rates at home—that is, as income rises and people want to buy more goods, they increase their demand for money. At the same time, if the opportunity cost of holding money goes up, the public moves away from money and into higher-yield assets. A third assumption is that changes in private domestic holdings of foreign securities—capital outflows or inflows—are a function of interest rates at home and abroad. Countries in the economy are assumed to be similar in these aspects.

The Mundell-Fleming models suggest that a government could manipulate monetary and fiscal policies in such a way as to attain internal and external "balance" simultaneously, namely, to achieve current account balance and full employment. This paradigm still motivates many of the discussions on international policy coordination.[8] For example, some analysts suggest that the U.S. proposal at the 1978 summit meeting of the G-7—that the United States, Japan, and Germany coordinate their policies in an expansionary effort—was motivated by the threat of trade deficits. If the incomes of a country and its trading partners grow simultaneously, other things being equal, the possibility of external imbalance (large trade deficits) is reduced.

These models assume that changes in domestic government expenditures influence domestic output, which in turn has an impact on the foreign country's current account and thus affects the level of foreign output. Likewise, a drop in the foreign country's output has an effect on the domestic current account and output.

The Mundell-Fleming models also illustrate how the effectiveness of aggregate demand policies in an open economy may be affected. For example, a policy increasing government expenditures, intended to lead to greater domestic output by stimulating purchases of domestic commodities, may be diminished in its effectiveness by a concurrent increase in purchases of import goods.

These models constitute a first step toward understanding the transmission of macroeconomic policy effects between countries. They demonstrate how the consequences of adopting certain policies at home depend not only on those policies themselves but also on policies implemented abroad.

To Coordinate or Not to Coordinate

Recognizing countries' interdependence and the potential for negative spillover raises the question of whether a country would be better off choosing policy on its own or in cooperation with other countries. The work of Koichi Hamada (1976) pioneered the analysis of international monetary policy coordination.[9]

Hamada's models are based on a game theoretical approach that views governments as solving their economic choices after considering a series of strategies, just as card players do (playing individually or as a team).[10] There is evidence that studying macropolicy coordination in the context of strategic considerations is a sound approach. For example, one could argue that it was not a coincidence that the North American Free Trade Agreement was put on the table at about the time that General Agreement on Tariffs and Trade (GATT) negotiations appeared to be stalling. A trade alliance within North America would show the European Community how the United States was ready to move forward with free trade, with or without the European Community. In fact, one could argue that it is progress toward NAFTA that has led to recent concessions in agricultural policy from the EC in the GATT negotiations.

Hamada's analysis was performed for a world in which exchange rates are fixed, which in fact they had been in the then-recent Bretton Woods era. However, Hamada's insights do not hold only for fixed exchange rates. In the framework of game theory, coordination of monetary policies would also be beneficial in a flexible exchange rate environment like those under which many countries operate today.

As an illustration, consider a world with free trade of goods and capital, and assume that there is a trade-off between unemployment and inflation. Countries choosing monetary policies independently may have a bias to choose an expansionary policy in order to achieve a target rate of unemployment. For instance, a particular country tries to lower its unemployment rate by running an expansionary monetary policy. Such a policy may trigger the following sequence of events: At least in the short run, there may be a depreciation of the country's currency with respect to other countries, which would in turn lead to a reduction of its current account deficit against those countries. The affected countries may react by pursuing expansionary policies themselves, in order to counter their currency's appreciation. In doing so, each country weighs only the inflationary consequences of its policies for its own economy (in the same way in which the factory owner causing water pollution in the example above does not internalize the negative impact of its actions). However, in the absence of any trade barriers the simultaneous expansionary policies would result in a higher rate of inflation worldwide. The fact of decentralized actions by countries precludes a country's ability to internalize the costs its actions impose on the world community. If, on the other hand, each of these countries were to give up its autonomy in choosing monetary policy, agree on a common objective, and have a central authority directing a single, common monetary policy, all would be forced to consider the worldwide inflationary impact of their policies.

Hamada determined that whenever free trade of goods existed, countries coordinating their actions generally achieved more desirable outcomes than resulted when countries acted independently. Hamada recognized, however, that coordination of monetary policies is difficult to achieve. A country faces trade-offs when setting economic goals, and coordination further restricts each country's already limited policy options to achieve the best possible developments at home.

Consequently, each country may assign different priorities to various goals. For example, assume that Germany and Italy have monetary policy at their disposal and that each recognizes the trade-off between inflation and unemployment. Germany may decide that low inflation is its priority while Italy may decide that it is willing to suffer higher inflation rates to achieve lower unemployment rates. Now consider that Germany and Italy decide to coordinate their efforts and relinquish their domestic monetary policies for a common central monetary policy. The question becomes how to assign weights to each country's objectives. That decision is a political one, about which economic theory is silent.

What is a policymaker to sift from these abstract concepts underlying coordination? The discussion so far seems to say that countries may be better off under coordinated policy than acting independently. More precisely, under free trade countries seem to benefit from choosing in unison a single, common policy. That observation is a potent policy recommendation. It is also, however, a typical example of theory having little to say about the actual process—the logistics and negotiations—required for its implementation.

Complete versus Incomplete Coordination

It is important to note that fixed exchange rate agreements and "managed" floating exchange rate agreements like the ERM are not the type of coordination Hamada studied. The nature of the policy coordination implicit in fixed exchange rate agreements may reduce exchange rate volatility and thereby improve efficiency. However, as was discussed earlier, under such incomplete coordination agreements the member countries continue to enjoy some degree of discretion over their macroeconomic policies and are not able to internalize fully the consequences of their policies. For example, Germany is still committed to the EMS, the intermediate goals that the EMS represents, and the eventual creation of a European Central Bank. But Germany's policy choices about financing its unification costs have prevented interest rates from coming down in Europe, indirectly creating negative externalities, or costs, for its neighbors. The type of policy coordination Hamada suggested above involves complete coordination—countries' total relinquishment of autonomous policies such as would characterize the EMU in its third stage, when a European central bank is in place.

It is important, however, to recognize that so far the theory on which a recommendation of complete macropolicy coordination is built has several shortcomings. For example, Hamada's models do not specify the mechanisms that affect consumption and investment decisions, making it hard to analyze the ways in which alternative policies may affect these behaviors. In addition, time plays no role in these models although interest rates are the price of intertemporal allocation of consumption and as such should require that temporal dynamics be a key consideration in analysis. Asset demands depend on current and future interest rates—for example, individuals choose assets to acquire on the basis of prevailing interest rates as well as expectations regarding future interest rates. Models such as Hamada's, however, are silent as to how agents build their expectations regarding future interest rates. Because they are static, they do not address the question of whether multicountry interdependence is only temporary. In spite of their shortcomings, these kinds of models constitute a solid first step toward understanding the international transmission of macroeconomic policies, and some of the models' insights apply for more complicated and realistic environments.

Dynamic General Equilibrium Models

Dynamic general equilibrium models were developed to address some of the problems identified above. These models reproduce the simultaneous nature of economic variables and assume that interest rates and prices are determined by the underlying economic structure rather than by exogenous behavior patterns that may not be related to the fundamentals of an economy. As their name implies, dynamic general equilibrium models are also able to incorporate the dynamic nature of economic systems.[11]

The models discussed earlier implicitly recommend international macroeconomic policy coordination. Given these models' shortcomings, however, it is important to investigate the robustness of that implication. Does the same policy prescription hold in a dynamic general equilibrium framework? The discussion that follows concentrates on models that address monetary and fiscal policy.

Monetary Policy. Neil Wallace (1984) set out to dispel the notion that there is a single "best" monetary policy for a nation. His model, which can be thought of as providing long-term recommendations, emphasized the notion (perhaps obvious but rarely acknowledged) that monetary policy has different effects across different economic groups. (Few would argue, for example, with the fact that U.S. monetary policy in 1992 generated a surge of mortgage refinancing at home but also displeased holders of three-month certificates of deposit, which experienced record low returns).

Preston J. Miller and Wallace's (1985) analysis of international coordination of monetary policies is an open-economy extension of Wallace's model. Miller and Wallace start with the observation that although countries appeared to have gained more discretion over their policies under a flexible exchange rate regime, flexible exchange rates did not ameliorate the transmission of negative spillover effects across countries. In this context, coordination of monetary policies has been abdicated as a means of improving the workings of flexible exchange rates.

Miller and Wallace's work is designed to contrast two approaches to choosing monetary policy. In the first, each country chooses its own monetary policy, recognizing the fact that other countries' independent decisions will influence the ultimate effects of its policy and that those decisions are beyond its control. The second alternative, akin to some of the G-5 or G-7 coordination attempts, involves all countries jointly organizing a central authority to choose a common monetary policy.

At the core of whether or not monetary policy coordination makes a difference is the fact that when countries choose policy independently of each other, their policies have asymmetric effects at home and abroad. Miller and Wallace illustrate this asymmetry with the following example. In their model, when the monetary authority in the United States engineers higher real interest rates at home, in a well-integrated international capital market long-term real interest rates will also tend to increase around the world. However, the impact of such policy on the purchasing power of economic agents trying to cash in their savings at the time the policy goes into effect will be different at home than abroad. A tighter monetary policy in the United States will increase the purchasing power of the people at home cashing in their savings, whereas it will reduce the purchasing power of the same group of savers abroad. Without themselves tightening, foreign countries suffer from higher rates, which translate into a heavier burden for servicing outstanding government bonds that would, in turn, require the central bank to monetize part of the government deficits. By acting independently of other countries in the Miller-Wallace model, the United States has failed to internalize the consequences of their actions abroad. If on the other hand all countries were to choose policy in unison, each would be able to internalize their policies' consequences for other countries and thus choose policy accordingly.

Miller and Wallace point out that although their analysis suggests that cooperation is desirable, it does not determine whether the common policy to be adopted should be a loose or tight monetary policy. And, as emphasized in Wallace (1984), the choice is important given that monetary policy does not have a uniform impact across economic groups.

In the Miller-Wallace model the final form of a common monetary policy evolves as a consensus that takes into account the weights assigned to different economic groups in the different countries. Unfortunately, economic theory suggests nothing in terms of how to distribute such weights; as in Hamada's analysis, such decisions are political ones that have to be hammered out in political negotiations. For this reason, Miller and Wallace are reluctant to view their analysis as prescribing a specific policy recommendation. They acknowledge, however, that their analysis suggests that adopting some common monetary policies could improve welfare worldwide.

A flavor of the negotiations necessary for resolving differences among countries attempting coordination was recently provided by the Maastricht Treaty. Danish failure to ratify the treaty in early 1992 and the nervousness over the French referendum vote later in the year may partially explain why the proposed third stage of EMU—the creation of a European Central Bank—seems sometimes so elusive.[12]

Fiscal Policies. During the 1980s the U.S. government deficit escalated to magnitudes on the order of 5 percent of the gross domestic product. As mentioned earlier, the size of the U.S. deficit has been seen as contributing to high interest rates worldwide. At the same time, the type of coordination among EC countries has gone beyond monetary policy to involve tax and industrial policies. In light of these developments, some economists have turned attention to analyzing the coordination of fiscal policies.

Patrick J. Kehoe (1987) investigated whether countries benefit more by coordinating their tax policies, particularly income taxes. Kehoe's analysis is developed in a dynamic general equilibrium model in which there is a household sector, a production sector, and a government sector. The government finances its expenditures via income taxes. Government-produced goods are turned over to households. Higher taxes lead to an increase in government-produced goods, which are valued by the current generation of households. Capital purchases, however, are a function of disposable income so that higher taxes lead to lower quantities of capital and, consequently, lower output and consumption levels for all future generations. Less capital also leads to higher real rates of interest (the interest rate goes up as capital becomes more scarce). These are the trade-offs that a policymaker has to consider in evaluating a tax policy.

As discussed earlier, when countries choose tax policies independently of each other but in the context of integrated capital markets, higher taxes will represent higher interest rates not only at home but also abroad; countries choosing policy independently do not internalize the consequences of their actions on interest rates worldwide. Under perfect integration of capital markets, the incentive to increase taxes at home increases with the number of countries in the world: A government acting on its own experiences the positive short-term effects of taxes regardless of the number of countries in the world; on the other hand, the government suffers only in a diluted way the negative cumulative effect of higher interest rates because their marginal contribution to higher interest rates worldwide is smaller the larger the number of countries in the world. Clearly, coordination of macropolicies again could allow all countries to internalize the negative externalities that they impose on each other, and, therefore, coordination is better than noncoordination of fiscal policies for all countries involved.

A natural question to ask at this point is whether cooperative outcomes of the sort described above will necessarily amount to giving up autonomy in choosing policy. Roberto Chang (1990), who has provided another model of fiscal coordination, also found that the world economy would be better served by having coordinated fiscal policies among countries. Chang has shown that under some circumstances countries would be able to internalize the consequences of their independent macroeconomic policies and thus avoid the transmission of negative externalities across countries without giving up autonomy in choosing policy. If, for example, countries pledged to impose fiscal self-discipline provided that other countries did the same, and if each threatened to abandon this discipline if others did, internalization would be possible. The policy implications of this research make its application promising: if credible threats could be implemented and the rules of the game clearly specified, there could be considerable savings of resources in achieving an outcome comparable to that of official coordination.

Can Coordination Be Undesirable?

While it is true that much of the economics literature suggests that under free trade coordinating macropolicies—both monetary and fiscal policies—is desirable, there may conceivably be situations in which coordination could be counterproductive. For example, Kenneth Rogoff (1985) has shown that cooperation among policymakers can in certain circumstances lead to a lower level of social well-being than independently set policy.

Rogoff's contribution hinges on the concept of "time inconsistency."[13] At the core of the idea of time inconsistency is the fact that there are incentives for governments and economic agents to renege on past commitments. Economic agents care about the sequence of their lifetime returns, not just consumption at a particular time. Individuals look ahead, and their expectations play a crucial role in their decision-making. If governments fail to recognize the importance of this process, they may pursue policies that seem optimal but involve reversing past commitments. For example, a government may announce that it will reduce capital taxes permanently to encourage investment. Once capital investment has taken place, the government may renege on its promise and raise capital taxes, promising never to do it again. Such a tax increase would not distort private investment decisions because capital investment has already taken place, and the government would have greater expenditure capabilities. However, economic agents observe the government's action and will discount future announced policies. In this scenario, the incentive for the government to renege on its promises may be recognized ahead of time, and the tax cut originally announced may be of little or no relevance. Such time-inconsistent policies seem likely to prevent society from achieving the best possible outcome.[14]

Rogoff found that when time inconsistencies exist, cooperation among countries can be counterproductive. For example, in the absence of monetary policy coordination any unilateral effort by a central bank to inflate (to engage in time-inconsistent policies) will cause its real exchange rate to depreciate, with the consequent price increase on imported goods driving up inflation at home. Such a concomitant depreciation and fears of accelerating inflation help check the incentives for a central bank to expand its money. However, in a cooperative arrangement the real exchange rate has no such tempering influence because each central bank can count on the others to match any money supply increase without any impact on the real exchange rate. Cooperation thus forces wage setters to set a higher rate of nominal wage growth in order to ensure that the central banks will ratify their target real wage. A cooperative regime may then be characterized by systematically higher inflation rates.

One criticism of Rogoff's findings is that the time inconsistency in his model exists because the governments' economic goals differ from those of their citizens (see note 14). It has been argued that if the governments and their citizens share economic goals, Rogoff's results may not occur. However, authors like Kehoe (1989) have shown that time inconsistencies can arise in settings in which governments and citizens share the same economic goals, thus leaving an environment where cooperation can be counterproductive.

Kehoe found that in the context of an open economy with capital mobility, a country's desire to renege on a promise not to tax existing capital is removed by the threat of capital flight; savings will flee the country with the highest income tax. Competition across countries and capital mobility act as an enforcer to eliminate time inconsistency. However, with fiscal cooperation between countries, this enforcement falls away because each government can count on the other to match any capital tax increase and thus eliminate the potential for capital flight. According to Kehoe's findings, international fiscal cooperation exacerbates the time-inconsistent problem and is therefore counterproductive. To summarize, if countries coordinate policies but cannot precommit to never deviating from the agreed-upon policy, such coordination efforts may be counterproductive.

The EMU: A Closer Look

Some economists argue that the goal of EMU is to establish a central authority that would set a common monetary policy and have member countries agree not to deviate from the policy. If so, coordination established under the auspices of the EMU should not be counterproductive.

It is a matter of some concern that the requirements established by the EMS for economic convergence are somewhat vague.[15] Further, each member country may fulfill the EMS requirements and still maintain dissimilar policies, and adherence to the guidelines may not be sufficient to guarantee a smooth transition to a monetary union. Even if a smooth transition is achieved and a common monetary policy adopted, there is no mechanism to ensure adherence to a common fiscal policy. For example, suppose that Germany met the guidelines to become a member of the EMU, that the union took place, and that all countries agreed to adhere to a common monetary policy. If Germany discovered at a later date that the burden of unifying the two Germanies implied larger-than-anticipated deficits, the country could de facto renege on the agreed-upon fiscal policies, creating the problem of time inconsistencies. According to the research reviewed above, only if EMU would lead to each member's precommitment to fiscal and monetary policy rules could a union be productive.

Partial Coordination

The bulk of the literature on international coordination concludes that coordination of macroeconomic policies that is complete and undertaken by all the countries in the world (at least all the countries that have a major impact on goods and asset prices worldwide)—in other words, "full coordination"—is preferable to having decentralized setting of policies.

As was discussed above, the rationale behind this dictum is that complete coordination allows countries to internalize the negative externalities that might otherwise be transmitted across countries. In reality, although there have been several initiatives to engage in full coordination, it has not been accomplished. Full coordination may, therefore, be thought of as a benchmark. More commonly, a small group of countries agrees to coordinate policies, and the result is "partial" coordination.[16] EMU is actually an example of this type of coordination.[17] In fact, the original goal for which the European Community was founded was to achieve free trade among its six members while adopting a common policy with respect to nonmembers. In view of that stated objective, recent research has concentrated on the issue of partial coordination, attempting to address the question of whether partial coordination is in fact superior to having each country make independent policy choices. If, as the discussion above indicates, full coordination is superior to independent policymaking, can it be assumed that the same is true of partial coordination?

When a coalition of some but not all countries is formed and policymaking is centralized, additional considerations will surface. For example, if the EMU eventually materialized and agreed to fiscal and monetary discipline that implied lower interest rates, it would be possible for nonmembers or outsiders to "free-ride" on the EMU member countries' efforts. An outsider would not internalize the impact of, for instance, its setting a loose monetary policy but would still be in a position to enjoy the positive impact of a complete coordination effort by the members of the EMU felt worldwide.

Stephen J. Turnovsky (1988) analyzes partial coordination using an economic model that emphasizes the negative spillovers on the terms of trade. He assesses the effects of a subset of countries in the world forming a union. In his analysis government spending is valued by private economic agents, such as spending for roads and infrastructure. Because domestic governments purchase import and export goods, they affect the terms of world trade. With no barriers to trade, one country's increase in government expenditure on export goods could, for example, raise the goods' relative price worldwide, thus affecting the purchasing power of other countries. As before, without policy coordination individual countries seem unable to internalize negative spillovers across countries. Turnovsky showed that countries that coordinate policy will in general have less government spending and, accordingly, less influence on the terms of trade. In this context, his model indicates that some coordination is better than no coordination at all. This conclusion rests on the rationale that as long as some fiscal discipline is imposed, its positive impact will be felt worldwide. However, the countries not bound by a coordination agreement can enjoy both improved terms of trade and larger government expenditures than those countries committed to a common policy. In that sense, countries not involved in the coordination agreement would be free-riders, raising the question of the frailty of partial coordination agreements. Given that free-riding is a possibility, countries would have an incentive to break away from the union. What are the implications for the future of agreements like the EMU?

Marco Espinosa and Chong K. Yip (forthcoming), using a dynamic general equilibrium approach, have found that the number of countries involved in a partial coordination agreement relative to the number of all countries is crucial in determining the sustainability of the agreement. Given groups of coordinating and noncoordinating countries, each country balances gains from coordination against gains from free-riding on others' coordination. If the number of countries involved in a coordination scheme is too small or too large, the gains to the coordinating members are such that the possibility of free-riding on the fiscal discipline of others does not outweigh the advantages of sticking to their coordinated policy. Espinosa and Yip show that there is, however, a "right-sized" coordination coalition of relatively homogenous countries. With the appropriate number of coordinating countries, the incentives to break away from the coalition disappear. Therefore, this research suggests that agreements like the EMU can be both beneficial and lasting.

Conclusion

Economic theory suggests that in the presence of open economies, free trade, and efficient capital markets, a country's policies will generate some externalities affecting the rest of the world community. When countries choose policies independently of each other, the impact of their choices on the world community cannot be fully internalized. Several of the coordination initiatives have implicitly acknowledged this fact. The discussion in this article establishes that under these circumstances coordination of macropolicies seems better for the world than having each country making independent policy choices.

The description of basic models of full coordination illustrates the complexity of the nature of international coordination and points to several issues that require further studied consideration. For example, given the desirability of a complete coordination effort, can it be inferred that incomplete coordination is better than none at all? Given the difficulties of implementing a complete coordination agreement, should countries instead spend energy trying to implement incomplete agreements? If countries agree to coordinate policy, how does an economic union choose a common objective? What are the difficulties faced by countries that precommit to coordinated policy adoptions and by the body of coordinating countries in ensuring adherence to agreed-upon policy? These are just a few of the areas of concern calling for attention from policymakers and researchers alike.

Notes

1. See Kahn (1987) for a review of some of these coordination efforts.
2. See, for example, Kumar and Whitt (1992) for a cross-country analysis of exchange rate variability on international trade.
3. See Chriszt (1991) for a review of the ERM.
4. One should not confuse these concepts with the distinction between full and partial coordination established below. The terms *full* and *partial* coordination refer to the number of countries relinquishing their policy autonomy—in other words, the number of countries involved in a coordination scheme.
5. President Mitterrand, for example, has been quoted as saying that countries that have already ratified the Maastricht Treaty could continue to move forward.
6. Some authors have taken pains to clarify the different degrees of international interdependence and coordination and the difference between coordination and cooperation. In this article, for simplicity, there is no distinction between coordination and cooperation. Several current studies—for example, Feldstein (1988)—similarly make no distinction.

   Cody (1989) and Humpage (1990), for instance, emphasize that the term *international cooperation* refers to the sharing of macroeconomic data and economic goals across countries. International coordination, on the other hand, refers to the joint setting of macroeconomic policies. By these definitions international cooperation includes the International Monetary Fund (IMF) and the OECD; some of the joint actions of the G-5 and G-7 are examples of international coordination.
7. For an excellent survey on the Mundell-Fleming approach to open economy macroeconomics, the reader is referred to Frenkel and Razin (1987).
8. See Caves, Frankel, and Jones (1993, chap. 22-23) for a textbook-level illustration.
9. For an updated survey see Cooper (1985).
10. See chapter 19 of Krugman and Obstfeld (1991) for a simple application of game theory to international coordination.
11. A common thread found in some of the literature on dynamic general equilibrium modeling is that the analysis of fiscal and monetary policies is based on the public finance approach originated by Ramsey (1928) and popularized by Lucas (1986). Lucas suggests viewing fiscal and monetary polices as trying to allocate distortions from taxes or subsidies in such a way as to maximize society's well-being over time. To be specific, this approach says that governments should choose taxes or subsidies so as to maximize the

well-being of all generations in a society. The choice of a tax-subsidy scheme explicitly incorporates a government sector that as a player in the international capital market can influence interest rates worldwide. This methodology represents a holistic approach to choosing "optimal" fiscal and monetary policies and as such is superior to a methodology that views them as independent of each other and assigns them different objectives throughout time.

12. For further analysis of the Maastricht Treaty see Kenen (1992) and Fratianni, von Hagan, and Waller (1992).
13. For a intuitive description of the concept of time inconsistency, see Mankiw (1992, chap. 12).
14. Rogoff (1985) studies international cooperation in setting monetary policies in a context in which such policies influence economic activity and the objectives of the private sector (wage setters) and governments are at odds with each other. This conflict arises from the assumption that the society's target employment rate is higher than the wage setter's target employment rate. Several factors can give rise to this situation—labor unions, for example. Labor unions are usually willing to accept a lower level of employment in order to bargain for higher wages for their members.

    Once wage setters set their nominal wages, the central bank can affect the rate of employment by inflating the economy. An increase in the price level would reduce the unemployment rate because a lower real wage raises the demand for labor. The monetary authorities, however, cannot systematically raise the level of employment through inflation. The private sector will eventually recognize this pattern and set nominal wage rates high enough to reflect their inflation forecast. As this process goes on and the central bank loses its credibility, the rate of inflation would increase consistently. This result does not imply that the central bank is irresponsible; it simply says that given the lack of precommitment to adhere to a policy's rules, a central bank's optimal choice each period may be to try to increase employment, at the expense of higher inflation.
15. The requirements for economic convergence of the EMU members include specific low-inflation targets, similar long-term nominal interest rates, quasi-fixed exchange rates, and fiscal discipline as evidenced by a low maximum ratio (3 percent) of a government's deficit to GDP.
16. A partial coordination scheme refers to a situation in which at least one country with influence in world economic activity chooses policy independently. This section considers only complete policy coordination, under which countries that are members of a coalition adopt common macroeconomic policies.
17. It is not a coincidence that this discussion has focused on the EMU and has only tangentially dealt with GATT. The type of analyses that deal with coordination of macroeconomic policies emphasizes intertemporal trade whereas the studies that deal with custom unions emphasize contemporaneous trade of different commodities. For an analysis of free trading zones, see Krugman (1991).

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Inflation and the Yield Curve

Peter A. Abken

The determinants of interest rates across the spectrum of bond maturities are of keen interest to the general public—borrowers and lenders—as well as to economists. Particularly during 1992, the spread between the shortest and longest maturity rates grew unusually wide, leaving many observers wondering what to infer from this gap (see Chart 1). Many, including some policymakers, see the current steep yield curve as an ominous sign of future inflation. The inflation forecasts implicit in interest rates carry strong credibility with most market observers because interest rates in part represent bets backed by wealth rather than casual forecasts with little at stake. The trouble is that interest rates are influenced by more than just market expectations of inflation; other factors cloud the inflation signal perceived in the term structure or relationship between interest rates.

This article discusses key past and current research studying the information on inflation contained in the nominal (face-value) term structure of interest rates.[1] The literature consists of two distinct but complementary strands. One analyzes the impact of inflation on interest rates; the other, the implicit inflation forecast in interest rates. The current evidence suggests that the yield curve does indeed give useful forecasts of inflation, especially at longer-term horizons, but much still needs to be learned about the various factors that influence nominal rates. The first section provides a background for the discussion in subsequent sections of more recent research. The second section considers research that has examined the short end of the yield curve, extending to bond maturities of one year. The final section looks at the longer-term yield curve. One pragmatic reason for this short-term/long-term dichotomy is that Treasury bill yields, which run to maturities of up to

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He thanks Will Roberds, Ellis Tallman, and Steve Smith for very helpful comments and Chris Holder for research assistance.

one year, are more readily analyzed than note and bond yields. Another reason is that, according to recent studies (discussed below), the term structure behaves very differently in these two maturity segments.

Background

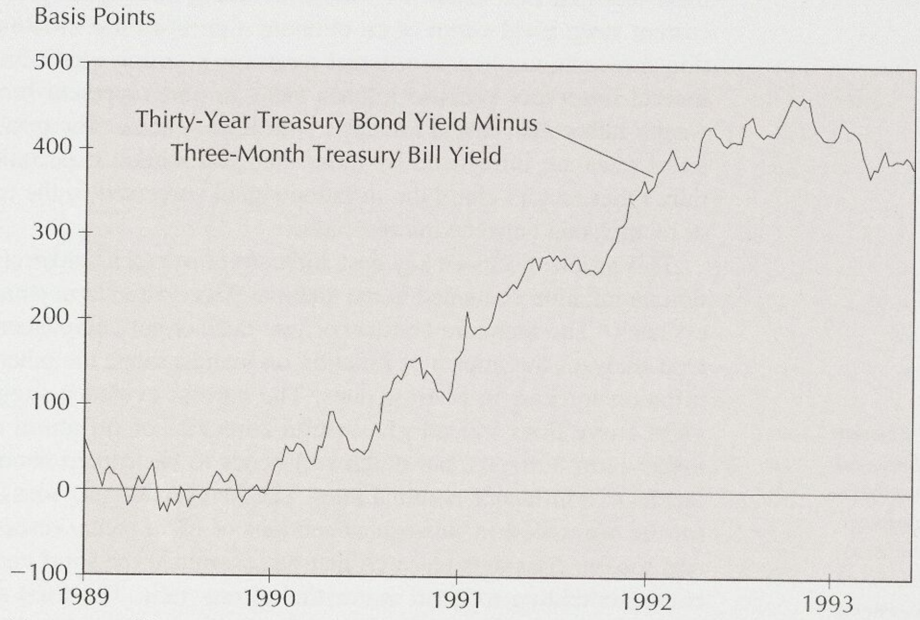
Numerous economists have viewed interest rates in terms of a decomposition into real (inflation-adjusted) and expected inflation components. In fact, the notion that interest rates reflect inflation expectations goes back centuries. Thomas M. Humphrey surveyed the historical development of the conceptual division of nominal rates into the real interest rate and expected inflation. According to Humphrey, the first record of such a distinction was made in the 1740s by William Douglass, a "Scottish-born physician, pamphleteer, controversialist, and student of American colonial currencies" (1983, 3). Douglass noted how lenders included an inflation premium in loans that were expected to depreciate in value because of the free printing of unbacked currency. Others to offer the same hypothesis before the twentieth century include Henry Thornton, John Stuart Mill, Alfred Marshall, and J.B. Clark. The fullest articulation of the distinction between nominal and real rates was by Irving Fisher in his 1896 treatise, *Appreciation and Interest*, and was elaborated further in his 1930 classic, *The Theory of Interest*.

Fisher viewed the nominal rate of interest in terms of a goods rate (or real rate) and a rate of appreciation (or inflation): "The theoretical relation [now called the Fisher relation] between interest and appreciation implies, then, that the rate of interest is always relative to the standard in which it is expressed. The fact that interest expressed in *money* is high, say 15 percent, might conceivably indicate merely that general prices are expected to rise (i.e., money depreciate) at the rate of 10 per cent, and that the rate of interest expressed in terms of *goods* is not high, but only about 5 percent" (1930, 41-42). Fisher expressed the future value of a dollar of principal (one plus the nominal interest rate) as the following product:

$$1 + i_t = (1 + \pi_t^e)(1 + r_t), \text{ or } i_t = \pi_t^e + r_t + \pi_t^e r_t,$$

where π_t^e is the expected rate of inflation over the coming period (for example, one year) formed at time t and r_t is the real rate.[2] This is the equation that Fisher derived in his 1896 monograph. For small real rates and expected inflation rates, the cross-product term is

Chart 1
Treasury Yield Spreads
(Weekly, January 4, 1989, to April 14, 1993)



Source: Board of Governors of the Federal Reserve System.

negligible. The logic of this equation is that if a loan were paid in a basket of goods, the interest charged would be r_t, also representing payment in goods, not money. Conversion into money after one period would be at the rate π^e_t, which gives the rate of exchange of money for goods. Inflation increases the dollar amount paid, and deflation diminishes it. In other words, an anticipated inflation is predicted to have no impact on the real return of assets denominated in fixed monetary value—for example, the real returns of bonds. This view was in accord with the prevailing classical monetary theory, which held that monetary phenomena, like inflation, only affect the price level and have no "real" effects. Although the Fisher relation is a straightforward concept, it has been very difficult to verify empirically because neither anticipated inflation nor the real rate of interest is directly observable.

In writing *The Theory of Interest*, Fisher in part sought an explanation for the so-called Gibson paradox. In a series of articles written in the 1920s, A.H. Gibson documented a strong positive correlation between the yields on long-term British bonds (Consols) and the level of a commodity price index over 130 years, which contradicted classical theory's prediction that the nominal rate and price level are independent. Fisher put the problem this way: "If perfect foresight existed [that is, if the Fisher relation held], continuously rising prices would be associated *not* with a continuously rising rate of interest but with a continuing high rate of interest, and falling prices would be associated not with a continuously falling rate of interest but with a continuing low rate of interest, . . . assuming, in each case, that other influences than price change remained the same [the real rate of interest is stable or constant]" (1930, 411-12).

The Fisher relation implies that the nominal interest rate and the *change* in the price level are positively correlated. Fisher attributed the Gibson paradox, which he confirmed in his own empirical studies of the correlation, to the sluggish adjustment of inflation expectations.

Thomas J. Sargent (1973) explained how Fisher's econometric work supposedly resolved the Gibson paradox by finding that expectations of inflation were formed adaptively on the basis of long lags of past inflation experience—ten to thirty years' worth. Fisher's proxy for unobservable expected inflation, a weighted summation over a long series of past price changes, is highly correlated with the price level (because the sum of long series of price changes will be close in value to the current level). Because of the implausibility of such long lag lengths, many later economists rejected Fisher's view that sluggish expectations formation explained the Gibson paradox.

Sargent found that the assumed direction of causation running from inflation to nominal rates was erroneous in Fisher's work and many subsequent studies. Fisher and other later researchers regressed interest rates (the dependent variable) on current and lagged inflation rates (the explanatory variables). Sargent showed statistically that inflation and nominal interest rates simultaneously cause each other through a feedback relationship.[3] He thus provides a link between the two distinct strands of the interest rate/inflation literature identified earlier. His analysis of the time-series properties of inflation and interest rate data led him to conclude that "the interest rate contains information, over and above that contained in lagged rates of inflation, that is useful in predicting the rate of inflation" (1973, 447). Much subsequent research has been devoted to evaluating the forecast power of interest rates for inflation.

Inflation and the Shorter-Maturity Term Structure

Eugene F. Fama is one of the founders of the efficient markets school of finance, which predicates its analysis of markets on market participants' rationality and on their efficient use of all relevant information in determining market prices. In Fama (1975) he took the view that, if the real rate of interest is approximately constant and markets are efficient, the nominal return on a Treasury bill would be correlated with the subsequently observed rate of inflation over the term of the Treasury bill. That is, nominal rates would move over time only because the expected inflation component of those rates changed. Furthermore, if inflation is predictable to some extent, rationality of inflation forecasts implies that nominal interest rate changes would move one-for-one with subsequently realized inflation on average. To test this hypothesis, Fama ran ordinary least squares (OLS) regressions of ex post (realized) inflation on interest rates, which according to Fisher contain the ex ante (expected) inflation rate. His examination of the very short end of the yield curve for the period from 1953 to 1971 confirmed his hypotheses that the market is efficient, the expected real rate of return was constant over the sample period, and variations in one- to six-month Treasury bill returns were statistically significantly correlated with subsequently observed inflation.[4] These results stand in sharp contrast to the previous empirical results that imply market inefficiency because of sluggish expectations formation.

Fama's article was influential and controversial. His conclusion that the expected real rate of interest is constant (at least over the sample period he examined) was criticized by a number of researchers (P.J. Hess and J.L. Bicksler 1975; C.R. Nelson and G.W. Schwert 1977; D. Joines 1977; K. Garbade and P. Wachtel 1978). They all detected some variation in expected real returns using different methodologies. Nevertheless, their results supported Fama's main point that interest rate fluctuations are driven predominantly by variations in expected inflation. Motivated by these critics' findings, Fama and Michael R. Gibbons (1982) hypothesized that the expected real rate evolves as a "random walk"—that is, changes in the expected real rate from one period to another are unpredictable and permanent. They estimated an inflation-interest rate regression similar to Fama (1975) but including a time-varying intercept term, representing the random walk of the real rate, instead of a constant. They found that, during the 1953-77 period, expected inflation over horizons of one month or one quarter also behaved like a random walk. Most important, using a more flexible econometric approach they reaffirmed Fama's earlier finding that fluctuations in expected inflation primarily account for variations in short-term interest rates. (The ratio of the variance of monthly expected real returns to the variance of the monthly expected inflation rate was .2, and the ratio using quarterly data was .25.)

Fama and Gibbons estimated and analyzed a negative correlation between expected inflation and expected real interest rates, which had previously been noted by a number of researchers.[5] A complete consideration of why a negative correlation exists is beyond the scope of this article, but for the sake of providing some economic intuition one prominent theory is sketched. The Mundell-Tobin theory (Robert Mundell 1963; James Tobin 1965) holds that an increase in expected inflation and associated higher nominal interest rates raises the opportunity cost of holding money, which earns no interest. People attempt to reduce money holdings for interest-earning assets, namely bonds, and doing so depresses their expected real return. In turn, the lower expected real rates stimulate capital investment, lower the return to capital (the real rate), and increase output. In fact, Fama and Gibbons advance a different explanation than Mundell-Tobin for the negative correlation. What is important for the following discussion of the Fisher relation is simply the existence of a correlation between expected inflation and real rates because of its statistical complications in drawing inferences from the term structure.

Frederic S. Mishkin (1981b) developed a new econometric approach for decomposing nominal rates into real rate and expected inflation components. Like Fama, Mishkin took the view that the bond market is efficient and employed the relatively new rational expectations methodology. Operationally, this approach simply provided a rationale for assuming that the market's inflation forecast errors are entirely unsystematic and unforecastable. This maintained hypothesis about market behavior allowed Mishkin to substitute the measurable ex post real interest rate for the unobservable ex ante rate in doing his econometrics, a well-established procedure in empirical rational expectations studies.

Symbolically, according to the Fisher relation, the nominal interest rate is $i_t = \pi_t^e + r_t$ (the sum of the ex ante inflation rate and ex ante real interest rate). The ex post real rate is measured as $i_t - \pi_t = (\pi_t^e + r_t) - \pi_t = r_t - (\pi_t - \pi_t^e)$, where π_t is the ex post inflation rate and the term $(\pi_t - \pi_t^e)$ is the market's inflation forecast error over some time interval like a month or a year. Mishkin assumed that the average inflation forecast error over a long period of time is zero, that is, unbiased, and furthermore that it is uncorrelated with itself over time and contemporaneously uncorrelated with other variables, like the real interest rate or the rate of inflation. In other words, the ex post real rate differs from the ex ante real rate only by an unforecastable "noise" term. These assumptions allow predicting the ex ante real rate on the basis of simple linear regressions of the ex post real interest rate on observable variables, such as past inflation rates, money growth, and unemployment rates, correlated with the ex post real rate.

Mishkin's approach was evidently partly motivated to counter the evidence that had accumulated against the Fisher relation, and bond market rationality generally, by researchers relying on survey data that he felt were seriously flawed (see Mishkin 1981b, especially footnote 7). His method did indeed find strong support for the Fisher relation. Though influential and widely cited, Mishkin's procedure has its shortcomings and its critics (see Kenneth J. Singleton 1981).

Mishkin (1990a) examined the shorter-maturity term structure and found that, contrary to Fama and Gibbons, the term structure communicates almost nothing about future inflation. Mishkin's regression analysis is very similar to Fama and Gibbons's. Mishkin estimates what he terms an inflation-change forecasting equation, which is reproduced here to aid the following discussion:

$$\pi_t^m - \pi_t^n = \alpha_{mn} + \beta_{mn}(i_t^m - i_t^n) + \eta_t^{mn}.$$

This equation expresses the ex post (realized) change in the inflation rate, measured as the rate over a longer future period m minus the rate over a shorter future period n, as a linear function of the difference or spread between two corresponding nominal interest rates, observed at time t. For example, the ex post difference in the rate of inflation over a six-month horizon versus a three-month horizon, both intervals starting at time t, is regressed on the time t spread between a six-month Treasury bill yield and a three-month Treasury bill yield. The regression assesses the implicit forecasted change in the inflation rate contained in the yield spread or "slope" of the term structure. The details of this equation's derivation from the Fisher relation are given in Box 1.

Statistical rejection of the hypothesis that $\beta_{mn} = 0$ indicates a significant correlation between the spread and future inflation. The hypothesis that $\beta_{mn} = 1$ means that the spread gives an unbiased forecast of future inflation (at least during the sample period). There are a number of explanations for the rejection of unbiasedness. One is that the ex ante real interest rate spread may also predict the change in the inflation rate, but this variable does not appear in the equation. In fact, it is implicitly a component of the disturbance term η_t^{mn}, which because of the real rate spread may be correlated with the nominal interest rate spread, biasing the slope coefficient away from one (see Box 1).

The regression can be recast in terms of the ex post real interest rate, with ex post inflation omitted. Mishkin shows the simple algebra that converts the inflation change regression into an ex post real interest rate change regression (ex post real rate regressed on interest rate spread), in which the slope coefficient is $1 - \beta_{mn}$. Thus,

Box 1

The inflation-change regression derives from the Fisher relation. The expected rate of inflation over m future periods is $\pi_t^{em} = i_t^m - r_t^m$ (and $\pi_t^{en} = i_t^n - r_t^n$ over n periods). Ex post inflation is expected inflation plus a forecast error: $\pi_t^m = \pi_t^{em} + \varepsilon_t^m$. With the Fisher relation, $\pi_t^{em} = i_t^m - r_t^m$, the unobservable expected inflation is substituted out of the equation for ex post inflation. The equation for ex post inflation becomes $\pi_t^m = i_t^m - r_t^m + \varepsilon_t^m$. The final step in deriving Mishkin's equation is to take the difference between equations for m-period and n-period ex post inflation rates. Because both the inflation rate (see Robert B. Barsky 1987) and nominal and real interest rates are close to being random walks, differencing is assumed to induce stationarity, which is necessary to satisfy OLS regression requirements for statistical inference. The resulting equation is

$$\pi_t^m - \pi_t^n = (i_t^m - i_t^n) - (r_t^m - r_t^n) + (\varepsilon_t^m - \varepsilon_t^n).$$

The real rate is further decomposed into a difference in the mean real rate over the sample period and deviation from that mean,

$$r_t^m = \bar{r}^m + (r_t^m - \bar{r}^m) = \bar{r}^m + u_t^m,$$

and similarly for the n-period horizon. The components of the spread in real interest rates,

$$r_t^m - r_t^n = (\bar{r}^m - \bar{r}^n) + (u_t^m - u_t^n),$$

are rearranged to facilitate the analysis. The difference in means over the two forecast horizons is subsumed in a constant term, $\alpha_{mn} = \bar{r}^n - \bar{r}^m$, and the real rate deviations are combined with the inflation forecast errors in a composite disturbance term, $\eta_t^{mn} = \varepsilon_t^m - \varepsilon_t^n - (u_t^m - u_t^n)$. This last equation is then converted into the final form of the inflation-change regression,

$$\pi_t^m - \pi_t^n = \alpha_{mn} + \beta_{mn}(i_t^m - i_t^n) + \eta_t^{mn},$$

where $\beta_{mn} = 1$ if the disturbance term is uncorrelated with the interest rate spread.

The disturbance term in the above regression, η_t^{mn}, will of course consist only of inflation forecast errors if the real rate of interest is constant. The real world turns out to be more complicated. By OLS regression theory, consistent estimation of β_{mn} with its "true" value requires that the disturbance term be uncorrelated with the interest rate spread. The rational expectations assumption ensures that the inflation forecast errors component of the disturbance is uncorrelated with the spread, but the real interest rate deviations can be and in fact are related to the spread, as demonstrated in numerous earlier papers, including Mishkin (1981b) and Fama and Gibbons (1982). Rejecting unbiasedness ($\beta_{mn} = 1$) therefore indicates that the slope of the *real* term structure fluctuates.

with two equations, forecast power of the spread becomes tautologically divided between explaining changes in real interest rates and changes in inflation.

For the period from February 1964 to December 1986, Mishkin found that the term structure for Treasury bills with less than six months to maturity has slope coefficients that are insignificantly different from zero. For inflation-change regressions using bills with nine- and twelve-month maturities, some forecast power was evident. Charts 2-4 show scatter plots of the variables that enter the inflation change regression, using data from July 1964 through September 1991 that were sampled quarterly to reduce the density of plotted points.[6] The values of (m, n), in months, are (3, 1), (6, 3), and (9, 6) for Charts 2, 3, and 4, respectively. The interest rate spread appears on the horizontal axis, and the ex post inflation change, on the vertical axis. In addition, monthly inflation/interest rate spread pairs are shown using two symbols: squares represent observations before October 1979, when the Federal Reserve changed its operating procedure to deemphasize targeting the Federal funds rate; diamonds represent post-October 1979 observations. As discussed in Mishkin's work, there is much evidence that nominal interest rates became more volatile after the change in operating procedure.

If the real interest rate were constant and the market had perfect foresight, all points would fall along a 45-degree line running from the southwest quadrant to the northeast quadrant in a plot with equal vertical and horizontal scales. Forecast and actual outcome would coincide exactly. Because the variability of actual inflation rates is so great compared with the variability of the nominal interest rate spread, the horizontal and vertical axes are drawn with different scales; consequently, the "45-degree" line is much less than 45 degrees in these plots. The inflation rate is notoriously difficult to forecast by any method, and thus large expectation errors are not surprising. The pre-October 1979 observations tend to cluster more tightly because of the lower volatility that characterized both yields and inflation during this period. Because interest-rate spreads at the short end of the yield curve tended to be positive during the sample period, most observations fall in the northeast and southeast quadrants.

The monthly inflation-interest rate spread pairs fall evenly above and below the horizontal axis. The inflation change regression lines in Charts 2 and 3 are flatter

Chart 2
Two-Month Inflation Change versus Three-Month–One-Month Yield Spread, Treasury Bills

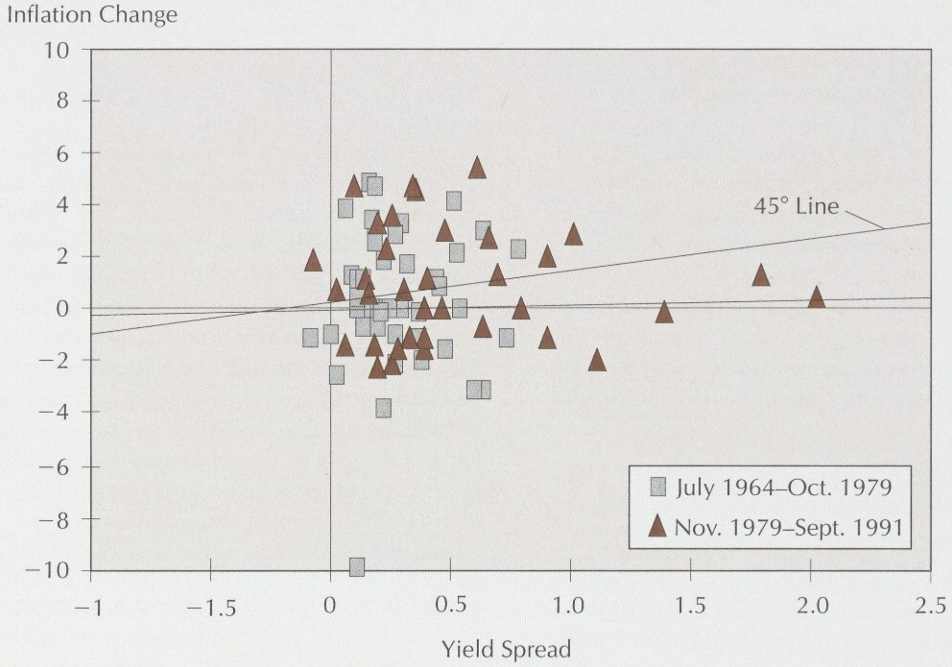


Chart 3
Three-Month Inflation Change versus Six-Month–Three-Month Yield Spread, Treasury Bills

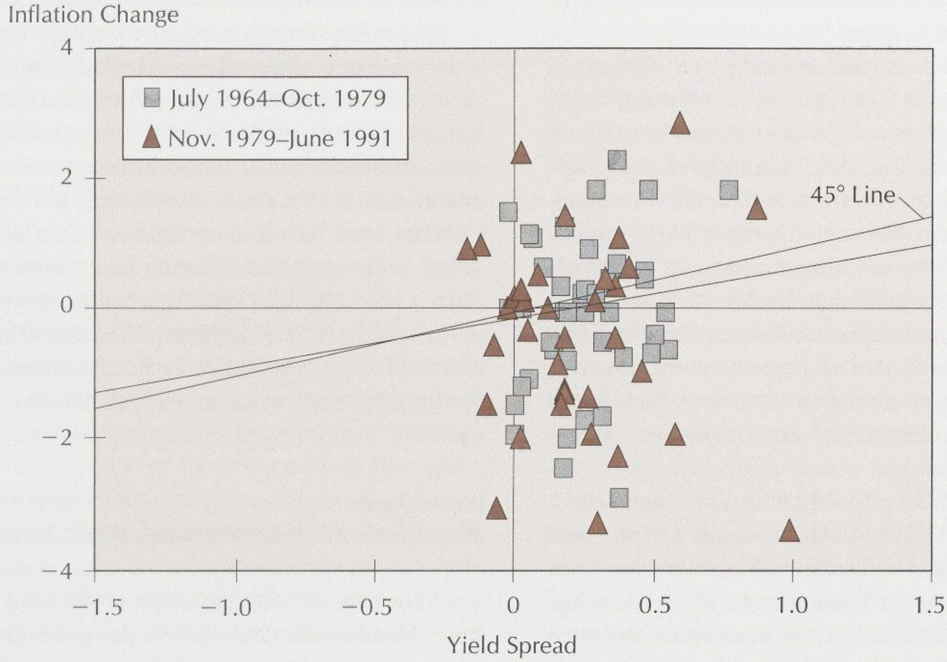
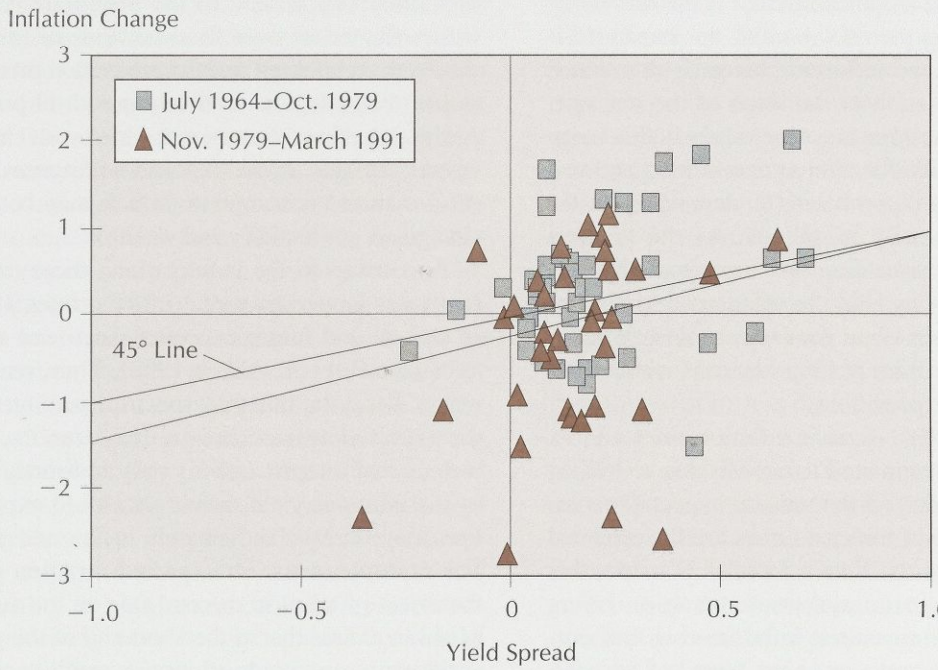


Chart 4
Three-Month Inflation Change versus Nine-Month–Six-Month Yield Spread, Treasury Bills



than the "45-degree" lines. Especially for Treasury bill maturities of less than nine months, as in Mishkin's work, the small slope coefficients and cloud-like dispersion of observations above and below the regression line indicate only a weak correlation between yield change and inflation change.

The flip-side of the inflation change regressions is the ex post real interest rate regressions. Mishkin found that the real interest rate slope coefficient, $1 - \beta_{mn}$, is highly statistically significant and not significantly different from a value of one for three-month/one-month interest rate spreads. However, spreads using longer maturities up to twelve months proved to be almost always statistically insignificant. Under the maintained hypothesis that expectations are rational, the implication of these results is that changes in nominal interest rates at the very short end of the term structure are based on variations in the real rate of interest, not inflation expectations.

Fama (1984), N. Gregory Mankiw and Lawrence H. Summers (1984), Gikas A. Hardouvelis (1988), and Mishkin (1990a) have all analyzed the determinants of the slope coefficient β_{mn}. Theoretically, the value of the slope coefficient depends on the correlation between the expected change in the inflation rate and the spread between real interest rates for the corresponding time horizon as well as on the ratio of the standard deviation of the expected inflation rate change to the standard deviation of the spread in real interest rates. Based on a fixed negative inflation-real rate correlation, the theoretical pattern for the slope coefficient is the following. For maturities of less than six months, the standard deviation of the expected inflation change is dominated by the standard deviation of the slope of the real rate. The slope coefficient takes negative values in this range but rises toward unity for twelve-month bills and can greatly exceed unity (approaching 2, depending on the correlation) as maturity lengthens. As the horizon moves to long-term maturities, the slope gradually falls back to unity, implying that the standard deviation of the real term structure slope goes to zero and all variation in the term structure at long horizons stems from changing inflation expectations.

In Mishkin (1990a), ex ante inflation rates and ex ante real rates were estimated using Mishkin's (1981b) technique, which relies on the rational expectations assumption that inflation forecast errors are uncorrelated with any variables at the time a forecast is made (that is, they are unsystematic and unpredictable). Using these estimates, the measured inflation-real rate correlation is −.8 on average, ranging from −.5 to −.97, depending on the sample period and maturity of underlying bonds being analyzed. Mishkin's regression results are therefore qualitatively consistent with his theoretical analysis. The pattern of slope coefficients as the forecast horizon lengthens roughly conforms to the theoretical shape given a negative correlation.

While this finding is suggestive, it is open to question because neither expected inflation nor the real interest rate is directly observable. Mishkin's analysis hinges crucially on the validity of the rational expectations assumption that inflation forecast errors are uncorrelated with expected inflation and ex ante real interest rates. Nonzero correlation of inflation forecast errors with expected inflation or ex ante real interest rates would also bias the slope coefficient away from a value of one. (See Singleton 1981 for other concerns about Mishkin's estimates.) Further consideration of the long-term interest rate analysis is given later.

Real Interest Rates and Risk Premia

What factors shift the slope of the real term structure? Mishkin does not address this point directly. More theoretical structure is needed to gain insights into the behavior of real interest rates, such as that in John C. Cox, Jonathan E. Ingersoll, Jr., and Stephen A. Ross (1985a) and Douglas T. Breeden (1986), which give the most comprehensive development of the contemporary theory of real interest rates. The real rate of interest is fundamentally related to the productivity of capital, which fluctuates over time because of unpredictable shocks to technology and the production process (for example, technological innovations and oil price shocks). At the same time, the real rate varies with changes in investors' attitude toward risk and willingness to save and defer current consumption (which may be induced by changes in productivity and wealth).[7]

According to the expectations theory of the term structure, longer-term real interest rates are averages of current and future expected short-term real interest rates (see Peter A. Abken 1990). Thus, real rates anywhere along the maturity spectrum are interrelated via the expectations mechanism. However, the term structure of real interest rates is only indirectly observable in the nominal yield curve; shocks to expected inflation may obscure movements in the real yield curve. For example, a rise in expected inflation may cancel the effect of a fall in the real rate on the nominal rate. Mishkin claims that at the short end of the yield curve, variation in expected inflation is small compared with variation in real interest rates.

The expectations theory is usually amended to allow for possibly time-varying term premia. Risk arises from the uncertainty surrounding both the nominal and real returns of Treasury securities. Because of unpredictable movements in real and nominal interest rates, a bond's real return (price appreciation plus interest earnings) over its life is always uncertain, as is its nominal return (unless the nominal bond is held until maturity). Term premia comprise risk premia and inflation uncertainty components. These are discussed in the next section. Subsequently, recent models of the nominal term structure are considered that explicitly treat the dynamics and interactions of real and nominal interest rates and risk premia.

Real and Nominal Risk Premia. Simon Benninga and Aris Protopapadakis (1983), Breeden (1986), and Martin D.D. Evans (1989) (among others) have considered risk and risk premia in the context of the Fisher relation. The upshot of their research is that under conditions of uncertainty, when real and nominal rates are explicitly modeled as evolving stochastically (randomly) through time, the Fisher relation fails to hold theoretically. In addition to the real rate and expected inflation, risk premia and the effect of inflation uncertainty are also components of the decomposition of the nominal rate.

Theory predicts two sources of risk, nominal and real, that require modifying the Fisher relation, which was derived long before the technical tools for modeling uncertainty were developed. The real risk premium of a nominal bond derives from the bond's usefulness in hedging against adverse changes in consumption. Bonds are stores of wealth; they transfer wealth from one time period to another. What investors ultimately value is the flow of goods and services that they buy through current income and savings. Risk-averse investors (who are also consumers) seek to smooth the flow of consumption over time. This is the basic conclusion from theories of optimal consumption and investment (Breeden 1986). Smooth consumption is preferred to low consumption one period followed by high consumption the next because the "disutility" of deficient consumption outweighs the added utility from surplus consumption, and bonds can help even out the consumption flow. Bonds that offer nominal returns that tend to be high when consumption is high (or, more technically, marginal utility of consumption is low) and low returns when consumption is low (marginal utility is high) must compensate investors for being relatively poor hedges against the risk of variations in the flow of consumption over time. If the risk premium were insufficient, risk-averse investors would avoid buying such bonds or would sell them and consequently drive down their current price and increase their expected return, other factors being the same.

The standard Fisher relation juxtaposes nominal and real (inflation-indexed) bonds of the same maturity.[8] Benninga and Protopapadakis show an alternative (but equivalent) formulation of the Fisher relation that highlights term structure relationships in the decomposition of nominal rates into real rates, expected inflation, and risk and uncertainty components. This approach equates longer-term bond prices with expected prices for equivalent roll-over investments in shorter-term bonds for the same holding period. The real term premium—the expected return on longer-term real bonds over and above that on shorter-term real bonds for the same holding period—reflects a longer-term real bond's ability to hedge consumption risk. The hedging characteristics will differ across real bonds of varying maturity, and consequently each will require a different level of risk premium. Intuitively, a real bond will include a positive risk premium if the sale of that bond before maturity generates a capital loss at the same time that consumption is low (and conversely capital gains when consumption is high).[9] The real risk premium may vary over time, for example, as investor wealth changes. Thus, in addition to fluctuations in short-term real rates over time, the real risk premium's own variation may contribute to shifts in the slope of the real term structure.

The nominal term premium is analogous to the real term premium. Nominal term premia may be informally viewed as the sum of two parts. One component depends on the nominal bond's usefulness as a hedge against shifts in future consumption, and thus the component is a real risk premium for a nominal bond. The other component reflects the inflation-hedging characteristics of a nominal bond. If longer-term bonds, for example, are more susceptible than shorter-term bonds to having their realized nominal returns over a given holding period wiped out to some extent by unexpected inflation (because of capital losses on the bonds), then they will be less desirable to own and will require extra return as compensation. Even if investors do not require a risk premium to bear consumption risk, the nominal term premium would still exist if the inflation-hedging characteristics of bonds differed across bond maturities.[10]

Benninga and Protopapadakis point out that only if nominal and real bond prices are highly correlated will nominal and real term premia have the same sign. In the extreme, if expected inflation were constant, real and nominal term premia would be identical, but in general they will be different and each may vary over time. Variability in real and nominal term premia contributes to shifts in the slope of the nominal term structure.[11]

Uncertainty about the future price level drives another wedge between nominal and real interest rates and is also another component of nominal term premia. This type of uncertainty is called the Jensen's inequality effect, identified by Stanley Fischer (1975), among others.[12] As the volatility of the price level increases (or equivalently, as the inflation rate becomes more volatile), the nominal interest rate falls relative to the real rate, other things being equal. The magnitude of the Jensen inequality effect depends only on the degree of variability of the future price level (technically, on its variance and possibly higher moments as well), not on the risk aversion of the consumers/investors in the economy. The effect is a mathematical phenomenon and does represent compensation for bearing risk.

Box 2 gives some simple examples of Jensen's inequality as applied to the expected rate of inflation as well as the economic intuition underlying the examples. Dilip K. Shome, Stephen D. Smith, and John M. Pinkerton (1988) found empirically that the Jensen inequality effect is not statistically significant in the Fisher relation, whereas their measure of the nominal risk premium is highly significant.[13]

Model-Based Studies of the Term Structure. Two recent studies, by George G. Pennacchi (1991) and Tong-sheng Sun (1992), use explicit models of the nominal and real term structures to measure the real rate of interest and expected rate of inflation. These studies employ a class of models that restrict interest rate movements along the term structure in such a way that there are no arbitrage opportunities possible (see Abken 1990). In other words, the models imply that the ex ante returns to investing in any bond or combination of bonds is the same for a given holding period, except for the possible addition of a risk premium (which augments the return but does not represent an arbitrage opportunity). Although these model-based studies are not about inflation forecasting per se, they do shed additional light on the results of regression-based studies.

Unlike previous research based on continuous-time term structure models, Pennacchi (1991) and Sun (1992) worked out tractable models that allow for the nonneutrality of money (specifically, an inverse correlation of real interest rates and expected inflation). The most important aspect of these models for the current discussion is their basic setup. Both assume that all term structure movements are driven by a small set of so-called state variables, which are the sources of unpredictability in interest rates. Both researchers use data sets on Treasury bill yields of various maturities to infer the relationship between the real rate and expected inflation. This approach contrasts with regression-based methods that examine the relationship at each maturity in isolation. The model-based approach captures the dynamics of the interest variables and is not intended to assess the forecasting performance of interest rates. Pennacchi's and Sun's work may be useful in gauging how expected inflation and real rates move through time.

Pennacchi estimated the parameters for two theoretical processes (that is, equations that describe the dynamics of variables) for the expected rate of inflation and for the real interest rate. A determinant of the real interest rate is the rate of return on physical capital, which represents the real wealth in the economy. The rate of return on capital is affected by the expected rate of inflation; consequently, the real rate of interest is also partly determined by expected inflation. The reverse is also assumed to be true. The expected rate of inflation is partly driven by the contemporaneous return on capital and by shocks to that return. Thus, like Sargent's earlier work on the Fisher relation, expected inflation and real interest rates are mutually determined in this model.

Box 2

The Jensen's inequality effect is illustrated using a simple example based on the mathematical derivation of the Fisher theorem in Benninga and Protopapadakis (1983). Even if investors do not require compensation for bearing risk (that is, if they are risk neutral), the real interest rate will not be equal to the nominal rate less the rate of expected inflation when inflation is stochastic. The basic point of the example below is to show that the expected inflation rate is not equal to the reciprocal of the expected change in the purchasing power of money and that the gap between these quantities widens as uncertainty increases.

The inflation rate measures the change in the nominal (dollar) value of a given basket of goods and services. The related concept of change in purchasing power assesses the change in the real value (in terms of the basket of goods and services) that a fixed nominal value will buy, that is, the number of units of the basket. Symbolically, for current price level p_0 (measured by an index) and future price level p, $E(p/p_0)$ represents one plus the expected inflation rate, and $E(p_0/p)$ denotes one plus the expected change in purchasing power. Although the Fisher relation is typically stated using expected inflation, purchasing power is more closely connected to the pricing of nominal assets.[1]

Suppose the initial price level p_0 equals 1 and the future price level p takes values 1.05 with probability .5 or 1.15 with probability .5. (That is, future inflation rates are 5 percent or 15 percent. This will be called the low inflation uncertainty case.) The (mathematically) expected price level is

$$E(p) = (.5 \cdot 1.05) + (.5 \cdot 1.15) = 1.10,$$

and the expected inflation rate is $[E(p)/p_0 - 1]) \cdot 100 = 10\%$. On the other hand, calculating the expected change in purchasing power entails taking the expected value of the reciprocals of the future price levels:

$$E(1/p) = .5(1/1.05) + .5(1/1.15) = .91097,$$

which is not the same as $1/E(p) = .909\overline{09}$. In other words, money's purchasing power is expected to drop by $[E(1/p) - 1] \cdot 100 = -8.9\%$ (after rounding) as compared with the case of constant 10 percent inflation in which the loss is −9.1 percent. The Jensen's inequality term is therefore approximately

$$E(1/p) - [1/E(p)] = .001882 \text{ or } .19\%.$$

In this example, an uncertain inflation rate slightly reduces the loss of expected purchasing power of money.

Now suppose the price level becomes more variable. The future price may go to 1.2 with probability .5 or stay unchanged at 1 with probability .5. (That is, future inflation is now 0 percent or 20 percent.) Repeating the earlier calculation, the expected inflation rate is still 10 percent, leaving $1/E(p)$ unchanged. However,

$$E(1/p) = .5(1/1.2) + (.5 \cdot 1) = .9166\overline{6}, \text{ or } -8.3\%,$$

making

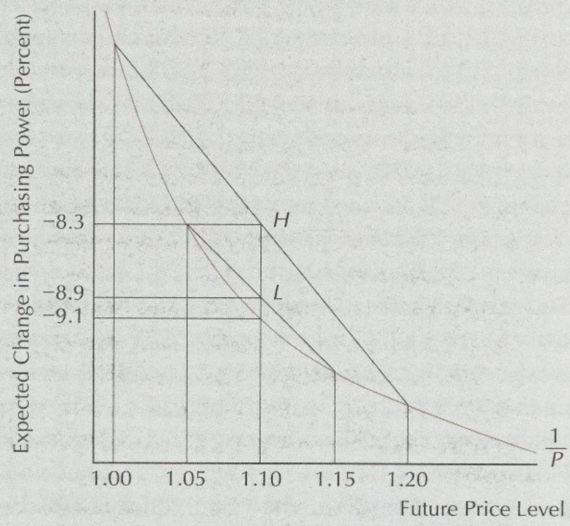
$$E(1/p) - [1/E(p)] = .0075\overline{75}, \text{ or } .76\%.$$

Thus, a more variable or uncertain inflation rate increases the expected purchasing power of money, $E(p_0/p)$.

The Jensen's inequality effect is shown in Chart A, which graphs the reciprocal of the price level against the price level itself. The low inflation uncertainty case, denoted by L, has an expected change in purchasing power represented by the midpoint of the chord within the hyperbola of the reciprocal price level. This point lies above $1/E(p)$ on the graph. The high inflation uncertainty case, denoted by H, has a chord that lies above the previous one and thus it has a higher midpoint, representing a greater increase in purchasing power. Note that the expected inflation rate of 10 percent is the same in both cases.

The economic intuition behind this example is that a more variable inflation rate results in an increase in the expected purchasing power of money, making nominal bonds relatively more attractive. Other things being equal, greater variability of inflation drives nominal bond prices up and their interest rates down relative to the real interest rate. Conceptually, the adjustment occurs so that in equilibrium investors are indifferent concerning holding nominal or real bonds.

Chart A
The Effect of Inflation Uncertainty on the Purchasing Power of Money



Note: The convexity of the graph of $1/P$ is greatly exaggerated for clarity. The vertical axis shows $[E(1/P) - 1] \times 100$.

Note

1. Fama (1975, 1976) formulates the Fisher relation in terms of purchasing power, not expected inflation. See also Benninga and Protopapadakis (1983) and Shome, Smith, and Pinkerton (1988).

To estimate the behavior of expected inflation, Pennacchi relied on the National Bureau of Economic Research (NBER) and the American Statistical Association (ASA) surveys of inflation predications by professional forecasters. Michael P. Keane and David E. Runkle (1990) found that these forecasts are unbiased and rational, consistent with the rational expectations assumptions underlying Pennacchi's model.

Pennacchi is not testing any particular theory about why a mutual dependence might exist between expected inflation and the real rate of interest. His purpose is to estimate econometrically the correlation between the real interest rate and expected inflation and how both variables react when one or the other is "shocked" away from its equilibrium level. The structure imposed on estimation by a term structure model enables him to make detailed predictions of the mutual dynamics of these two variables.

From 1968 to 1988, the "instantaneous" correlation between the innovation (unpredicted component) of expected inflation and that of the real interest rate was a statistically significant –.376. Consistent with Mishkin's results using regression-based methods for the shorter-maturity yield curve, Pennacchi found that the real interest rate is much more volatile than the expected rate of inflation. Unlike Mishkin, Pennacchi has modeled real and nominal risk premia and thus separately identifies movements in the real interest rate, rather than movements in a composite of real interest rate and risk premia. The model also reveals that the real rate of interest is much slower to return to its equilibrium level than expected inflation is to return to its corresponding equilibrium rate.

Sun (1992) achieves modeling objectives similar to Pennacchi's in statistically characterizing the dynamics of the real interest rate and expected inflation. Sun extends the celebrated Cox-Ingersoll-Ross (CIR) term structure model (see Cox, Ingersoll, and Ross 1985b and Abken 1990) to allow for money nonneutrality. One important feature of the CIR model is that the volatility of nominal and real interest rate processes is proportional to the level of the shortest-term interest rate. This characteristic accords with empirical evidence in a number of studies (see K.C. Chan and others 1992). That is, nominal and real interest rates tend to be more volatile when rates are high than when rates are low. Pennacchi's model assumes that nominal and real rates have constant volatility, an assumption that potentially biases his estimates because his model may be misspecified. (Of course, the CIR model may also misspecify the volatility.) Sun posits a process generating expected inflation, but he does not rely on survey data to estimate the parameters of that process. Instead, he uses data on the Consumer Price Index and statistically models the joint conditional distribution of his (unobservable) state variables and the rate of inflation. The prices of two Treasury bills of different maturity serve to substitute (instrument) for the unobservable variables. The bond prices are complicated nonlinear functions of the state variables and price index; this is the point at which the CIR model, modified for money nonneutrality, comes into play.

Like Pennacchi, Sun rejects the hypothesis of money neutrality. The correlation coefficient between the unobservable state variable summarizing uncertainty in the real economy and the inflation rate is significantly positive (not zero). Sun does not estimate a correlation between real interest rates and expected inflation, but the implication of his result is the same, namely, that the strict Fisher relation does not hold and expected real rates are not independent of expected inflation. He estimates a positive nominal risk premium, which means that the nominal interest rate is greater than the real rate plus expected inflation. Furthermore, because of the CIR specification, the magnitude of the risk premium varies over time in proportion to the level of the state variable, whereas Pennacchi's risk premia are constant over time. Nevertheless, both models produce qualitatively similar graphs of the real interest rate and expected inflation.

The work of Pennacchi and Sun reveals that real short-term interest rates undergo significant variation. The real interest rate was more volatile than expected inflation during the 1970s and 1980s.[14] These findings help to clarify Mishkin's regression results, which indicate that at the short end of the yield curve variations in nominal yields reflect (and forecast) changes in the slope of the real term structure, not changes in expected inflation. Regression-based methods alone cannot sort out the factors moving the real term structure.

Inflation and the Longer-Maturity Term Structure

Mishkin (1990b) extended his investigation of the term structure to maturities of longer than one year. He reestimated his inflation-change regressions for zero-coupon bonds, derived from actually traded coupon-bearing bonds. These bonds were constructed with maturities of one, two, three, four, and five years; all yield spreads were formed relative to the one-year bond. The corresponding changes in the CPI were similarly computed.

Mishkin generally found that the estimated β_{mn} are greater than unity, sometimes near 2.0, and are all statistically significant. As noted earlier in the discussion of shorter-maturity term structure, the slope coefficient from the inflation-change regression depends on the correlation between the expected change in the inflation rate and the spread in the real interest rate as well as on the relative volatility of the expected change in the inflation rate and the real interest rate spread. During his 1953-87 sample period, the correlation ranged from −.7 to −.95, depending on the underlying discount-bond maturity. According to Mishkin's interpretation, this correlation, combined with high volatility of expected inflation, pushes the slope coefficient toward values near 2, particularly in regressions using longer-term discount bonds.

The regression R^2's (the ratio of explained to total variation in the change in inflation) was 20 percent at the two-year maturity ($m = 2$) and more than 40 percent for four- and five-year maturities. These results compare with R^2's for the shorter-maturity inflation change regressions of less than 10 percent and with those of less than 5 percent for maturities less than nine months. Thus, longer-maturity interest rate spreads have statistically significant power to forecast changes in future inflation.

Charts 5-8 illustrate Mishkin's results for the longer-maturity term structure by means of scatter plots using quarterly sampled monthly observations on yield changes and inflation changes for the 1964-91 sample period. These are parallel to Charts 2-4, although all changes are now expressed in terms of the one-year bond yield and one-year rate of inflation. The values of (m, n), in years, are (2, 1), (3, 1), (4, 1), (5, 1) for Charts 5-8, respectively. As before, squares represent pre-October 1979 observations, and diamonds stand for post-October 1979 observations. The scatter plots show a distinct tendency for points to cluster in the northeast and southwest quadrants, which indicates spread predictions of subsequent inflation in the right direction.

Fama (1990) also studied one- to five-year maturity discount bonds constructed from coupon bonds, and his work is very similar to Mishkin's (1990b) in methodology and results. Fama focused on the forecast power of the spread between five- and one-year discount bond yields because other intermediate spreads are almost perfectly correlated with this spread. The spread serves as a single explanatory variable in several related regressions. One equation is an inflation-change regression identical to Mishkin's. Fama also regresses the ex post change in the real interest rate, defined as the change in the one-year (spot) rate minus the change in the CPI, over fixed periods from one to five years long. A third equation regresses the change in the one-year rate on the spread. As Fama shows, by definition the ex post change in the real rate plus the change in inflation equals the change in the spot rate. Thus, the regression coefficients—that is, constant term and slope—in the estimated real rate and inflation equations sum across regressions to their estimated values in the spot rate equation. (Mishkin makes the same point in his research.) Finally, Fama also regressed the term premium, measured by the ex post holding period return on discount bonds of two to five years in maturity minus the one-year rate, on the spread. In assessing the regression results, Fama observed that "the yield spread is the jack-of-all-trades. It responds to information about term premiums and future spot rates, inflation rates, and real returns" (73). He emphasizes that variation in expected term premiums, which appear to be correlated with the business cycle, obscure the forecasts of the yield spread for the other variables. The regression evidence indicates that this variation grows stronger as maturity lengthens.

A consequence of the spread's containing information about a number of variables is that it forecasts each imperfectly if the variables are not themselves perfectly correlated with one another. Particularly for one-year bonds, the spread predicts changes in the real rate that are of opposite sign and almost equal magnitude to changes in expected inflation. Again for the one-year bond, the R^2 is 23 percent for the inflation equation but only about half that amount for the real interest rate equation. As the horizon lengthens to a maximum of five years, the spread continues to have significant forecast power for inflation but virtually none for the real rate. Another way to view Fama's regression results is to examine the spot rate equation. The offsetting coefficients for the inflation and real rate equations necessarily imply that the spread has no value in predicting changes in the spot rate. Only at longer horizons does the spread have utility in forecasting the change in the spot rate, precisely because changes in that rate are predominantly determined by changes in expected inflation.

A recent study, by Werner F.M. De Bondt and Mary M. Bange (1992), has challenged the view that inflation forecast errors are rational in the sense that Mishkin and Fama assume. As discussed above, Mishkin's and Fama's interpretation of the slope coefficient in the inflation-change regressions hinges on inflation forecast errors not exhibiting systematic errors. There is no

Chart 5
One-Year Inflation Change versus Two-Year–One-Year Yield Spread, Treasury Bonds

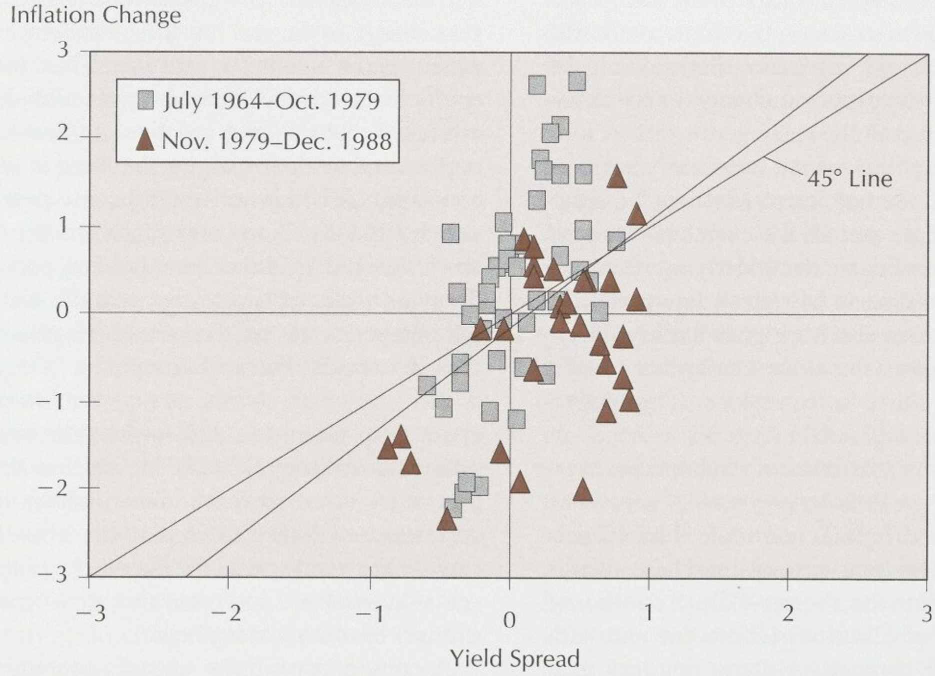


Chart 6
Two-Year Inflation Change versus Three-Year–One-Year Yield Spread, Treasury Bonds

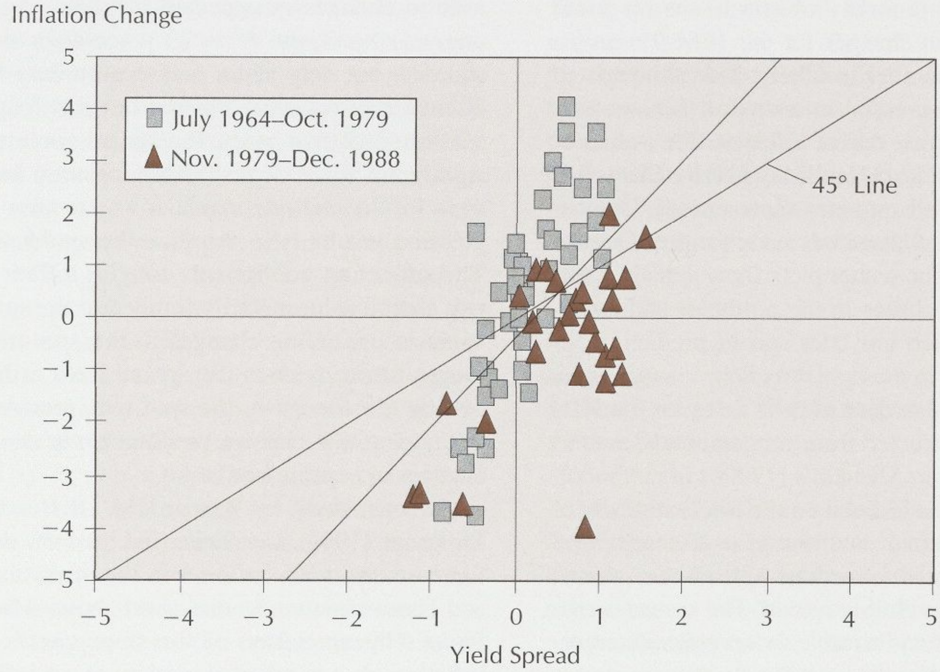


Chart 7
Three-Year Inflation Change versus Four-Year–One-Year Yield Spread, Treasury Bonds

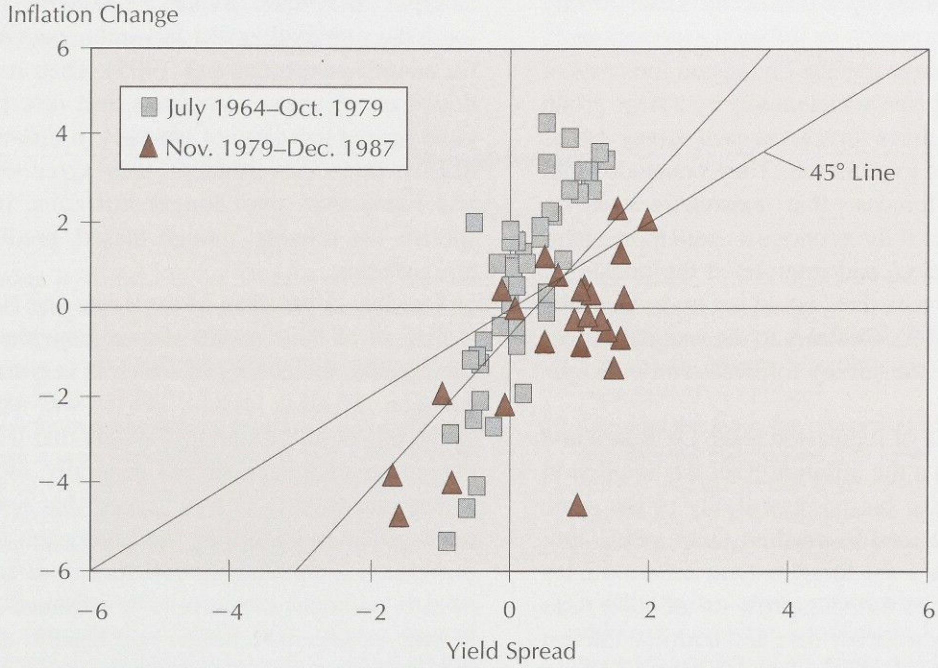
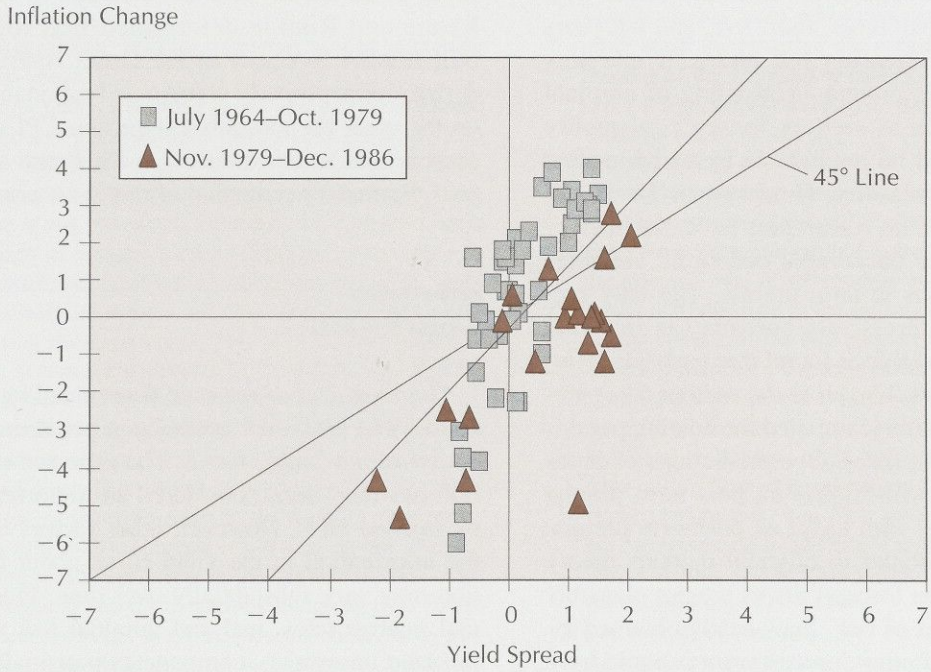


Chart 8
Four-Year Inflation Change versus Five-Year–One-Year Yield Spread, Treasury Bonds



way to know whether systematic inflation forecast errors influence the regression results without additional information on expected inflation. (Fama and Mishkin simply assume that the forecast errors are unsystematic.) De Bondt and Bange try to address this issue directly by using survey information on inflation expectations.[15]

De Bondt and Bange use the Livingston forecasts of the CPI, which are given semiannually by a large group of economists. The mean forecast at each survey date is taken as the market expectation. They conclude from their tests of these forecasts that "expectations are insufficiently adaptive: if the economists paid more attention to recent inflation, and interpreted the prevailing rate as less of a surprise, they would not make the same error repeatedly" (485). Contrary to the rational expectations assumption, the survey forecast errors are systematically biased.

Using another set of regression tests, De Bondt and Bange determine that the inflation forecasts implicit in interest rates are also biased, essentially in the same way Fisher had noticed more than sixty years ago: nominal interest rates rise too slowly as inflation rates accelerate and decline too sluggishly as inflation rates abate. The Livingston survey data and nominal interest rate spreads predicting inflation over the same horizon were found to be highly correlated, implying that the two are biased in the same way.

De Bondt and Bange's strongest results concern the ability of past inflation forecast errors to predict ex post term premia. These term premia were computed as the excess returns on discount bonds with maturities of one, two, three, four, five, and ten years over the six-month Treasury bill return. If investors are risk averse, term premia—consisting of nominal and real risk premia as well as Jensen's inequality components—should be predictable by variables that measure risk and volatility. However, as De Bondt and Bange point out, no researchers have convincingly identified ex ante observable economic variables that predict variations in term premia. The only predictor has been interest rate spreads (as in Fama 1990). De Bondt and Bange found that past survey inflation forecast errors (known at the current date) predict ex post term premia (computed for holding periods starting at the current date). Overpredictions of inflation are correlated with higher ex post term premia and underpredictions with lower ex post term premia. This finding runs counter to efficient markets theory because past inflation forecast errors are not plausibly regarded as measures of risk. Such easily obtained information as past inflation forecast errors should have no value in predicting future interest rates in an efficient, "rational" market. De Bondt and Bange conclude that "the inertia in expectations may be rational if we consider the costs and benefits of more accurate forecasts and/or possible regime changes [for example, changes in Federal Reserve operating procedures] (with the implication that rational expectations resemble adaptive expectations)" (495). Their research casts doubt on Mishkin's analysis and interpretation of yield spread forecasts of changes in inflation and real interest rates. Nevertheless, they agree with Mishkin and Fama that, over longer horizons, interest rate spreads are reliable, though biased, predictors of future inflation.

One line of criticism of De Bondt and Bange's work is that all of their results derive from the Livingston survey data, the quality of which is very much open to question. Mishkin (1981a, 1981b) was an early critic of the biases in the Livingston data that were then imputed to market expectations generally. More recently, Keane and Runkle (1990) argued that not all economists polled in compiling the Livingston forecasts are professional forecasters and therefore some do not have an economic incentive to be informed and accurate in their projections. Keane and Runkle also stressed that averaging across forecasts to get a "consensus" forecast when individual respondents have different private information can lead to severe biases detected in rationality tests. In light of Keane and Runkle's study, Pennacchi (1991) relied on the NBER-ASA forecasts, which represent professional forecasters' predictions.[16] One should be concerned that on the one hand Keane and Runkle determined that the quarterly NBER-ASA forecasts of the Gross National Product deflator pass properly constructed rationality tests, yet on the other the monthly Livingston CPI survey forecasts appear to be so biased in De Bondt and Bange's tests. Further investigation of this issue is needed.

Conclusion

Nominal interest rates are determined by a variety of factors that limit their accuracy in predicting the future course of any single factor. The expected rate of inflation has long been considered an important influence on interest rates. However, other factors that obscure the information in the yield curve about future inflation may vary substantially over time. Fluctuations in real interest rates, real and nominal risk premia, and inflation uncertainty components potentially cloud the term structure's information on inflation.

Despite the complexity of interest rates, most people who want to gauge inflation expectations turn to the yield curve. There are clearly many unresolved issues concerning the behavior and dynamics of nominal interest rates and their relation to expected inflation. Nevertheless, recent empirical research demonstrates that the yield curve does give a relatively reliable forecast of inflation, particularly at longer horizons. A fruitful area for future research is assessing the comparative value of implicit yield-curve forecasts versus alternative methods for making longer-term inflation forecasts.

Notes

1. All discussion is in terms of the Treasury yield curve because firm- or agency-specific credit risk complicates the analysis for non-Treasury bonds.
2. See Humphrey (1983, 7) for the arbitrage argument Fisher used in deriving this formula.
3. Sargent tests for mutual feedback statistically and argues that the apparent mutual dependence works indirectly through other omitted variables that influence inflation and interest rates. He developed a simple macroeconomic model that gives rise to the Gibson paradox in artificial data simulated by the model. Unlike Fisher's explanation, long lags in forming expectations of inflation play no role in Sargent's model. He concludes that simple regressions of interest rates on current and lagged inflation rates do not necessarily provide any information on the process of expectations formation.
4. Because Fama computed Treasury bill returns assuming that bills were held to maturity, the return is the same as the yield—that is, a bill matures with fixed face value, which means that its rate of return is known at the time of purchase. The future return would be uncertain if the bill were sold before maturity.
5. See Mishkin (1981b, 164) for references as well as Fama's critics cited above.
6. The inflation rate is computed as the annualized difference in logarithms of the seasonally unadjusted Consumer Price Index. The inflation change is then the difference in inflation rates over an m-month horizon versus an n-month horizon, where $m > n$. The interest rate data are from the Center for Research in Securities Prices (CRSP) and are end-of-month annualized, continuously compounded yields. End-of-month yields are aligned with the following month's CPI in estimating the regressions. The first month's observations each quarter were included in the scatter plots, and the regressions were run on these sampled data points.
7. Cox, Ingersoll, and Ross (1985a, 372) make the point that the real interest rate can be different from the expected rate of return of direct investments in physical capital (or equities) because of the differences in the hedging characteristics of investment in real bonds or physical capital. The real rate of interest can in principle be greater than the rate of return on physical capital if equities hedge against future shocks to consumption. In effect, investments in real or purchasing power bonds in this case would require a risk premium—extra compensation—to induce investors to buy these bonds. Further discussion of the real risk premium is given later in this section.
8. This discussion of real (inflation-indexed) bonds should be viewed as a thought experiment because real bonds do not trade in the United States.
9. Consider the following two-period (three-date) example using discount bond prices. The forward price of a real bond to be issued one period from now and maturing one period later is by definition equal to the two-period bond price divided by the one-period bond price. In a risk-neutral world, this forward price is the expected price of the one-period bond to be issued one period from now. In a world with risk-averse investors, however, the forward price equals the expected one-period price plus a risk premium. Technically, this risk premium is proportional to the covariance of the investors' discounted marginal rate of substitution (ratio of future to current marginal utilities of consumption) with next period's one-period bond price. In plain English, a two-period bond will include a positive risk premium if the sale of that bond after the first period generates a capital loss at the same time that consumption is low (and conversely capital gains when consumption is high). On the other hand, the maturing one-period bond pays off its face amount of the commodity-services basket (see Box 2). In other words, the covariance of return with consumption for the longer-term bond makes it a poorer consumption hedge than the shorter-term bond.
10. This inflation-hedge component would be present even if investors were risk neutral. Technically, the nominal risk premium is proportional to the covariance of the product of the marginal rate of substitution and change in purchasing power with the price of the future one-period nominal bond (in the context of the two-period example in note 9). Risk neutrality implies a constant MRS, making the covariance simply between purchasing power and the nominal bond price, which is not a risk premium per se.
11. Empirical researchers often lump any variation in nominal rates arising from nominal and real risk premia (and uncertainty components) into their measure of the real interest rate, as is the case in Mishkin's application of the Fisher relation in Box 1. See also Mishkin (1981b, 167) and De Bondt and Bange (1992, 490).
12. See especially Benninga and Protopapadakis (1983, 859) for a derivation of Fisher's theorem under conditions of uncertainty.

13. In particular, their test of the Fisher relation could not discriminate between measures of expected price change in terms of inflation or changes in purchasing power. Both were estimated with coefficients insignificantly different from one, the theoretical value as implied by the Fisher relation.

    In a slightly different context, Campbell (1986) found that a Jensen inequality effect that distinguishes several versions of the expectations hypothesis of the term structure is of second-order importance and can be ignored in empirical work.

14. Sun does not discuss the derived time series for expected inflation and real interest rate in any detail, except to note that expected inflation is much "smoother" than actual inflation. Both series are plotted in his Figure 1. Pennacchi's are shown in his Figure 7. Sun observes that the nominal risk premium is positive but does not analyze any other characteristics of the derived premium, which would have been an interesting exercise.

15. Pennacchi also used survey information, although his purpose was different from De Bondt and Bange's. Based on the work of Keane and Runkle that showed how the quarterly NBER-ASA survey data satisfy the rational expectations assumptions, he used the survey data as an input in estimating a nominal term structure model.

16. Pennacchi addressed the aggregation bias issue identified by Keane and Runkle by using the median instead of the mean forecast error, a choice that puts less weight on extreme individual forecasts.

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FYI

Consumer Prices: Examining Housing Rental Components

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The Consumer Price Index (CPI) is one of the most closely followed economic indicators of conditions in the U.S. economy. It is one of a number of broad price indexes that attempt to measure inflation—that is, the rate of change in prices. For many reasons, a sound measure of price changes, especially at the consumer level, is important. CPI data are used by monetary and fiscal policymakers, by participants in financial markets, by economic forecasters, by people writing contracts with cost escalation clauses (cost-of-living adjustments, or COLAs), and by average consumers who worry about whether pay raises are keeping up with prices for goods and services purchased. In addition, the federal government uses the CPI to adjust Social Security payments and income tax brackets and standard deductions for personal income taxes.

For all these users of CPI data, it is important that the data accurately measure what is intended. However, a number of economy watchers have questioned the accuracy of the CPI and several of its components.[1] One important set of components that has been called into question on several occasions measures housing rental costs.[2] Most recently this set of measures has raised questions when during the recession of 1990-91 and subsequent recovery—while housing prices were depressed, apartment vacancy rates remained high, and hotel vacancies were rising—rental CPI components were stronger than expected. Because these rental components make up more than one-fourth of the CPI, including figures for residential rent (tenant-occupied housing),

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owners' equivalent rent (owner-occupied housing), and lodging while out of town, the concern over rental components is legitimate.[3] Possible flaws in such a considerable portion of the CPI's components by weight would certainly call into question the CPI's overall accuracy as a measure of inflation.

This article attempts to address the issue of how well the CPI rental components reflected actual conditions from 1990 to 1992 and examines the sources of apparent divergence. The discussion first explains BLS methodologies for the housing rental series, including changes in methodologies within the time frame studied that affected movement in the data. The various CPI rental components are then compared with corroborating independent data series to assess the validity of the CPI components. Two alternative hypotheses are considered that might help explain the divergence from expectations for the residential rent, owners' equivalent rent, and lodging-while-out-of-town CPI subcomponents. The first is that the BLS methodologies are flawed or no longer relevant. The second explanation investigated is the possibility that popular concepts of what is measured differ from what the CPI methodology actually covers.

The CPI is a measure of the cost of goods or services currently being consumed. It therefore seeks to measure the cost of housing services or, in other words, the cost of the use of shelter. Investment considerations reflected in the cost of obtaining a house are not part of the consumption cost concept that the CPI attempts to measure.

What Is the CPI?

Precisely defined, the CPI is a measure of the average change in prices paid by urban consumers for a fixed market basket of goods and services.[4] Currently, the CPI includes approximately 360 categories of items, with the weight of each component series determined by actual consumer expenditure patterns as measured by the Bureau of Labor Statistics' Consumer Expenditure Survey (CES). The market basket currently used as a benchmark reflects the spending habits of urban consumers from 1982 to 1984, with categories generally assigned weights according to the average consumer expenditure in each category relative to total expenditures for items covered in the CPI.[5]

It is significant that over time each component's relative importance in the index changes as component prices do not move together uniformly. A component's relative importance is essentially its original base-year weight multiplied by its price growth relative to other components. It is these share figures that reveal the significance of housing in the CPI.[6] Table 1 shows the sizable shares that both the housing expenditure group and the rental components have in the CPI.

The Significance of Housing

Why are the rental components—owner-occupied, tenant-occupied, and lodging—critical for understanding trends in the CPI? As was explained earlier, in simple terms housing rental components matter because they form a large portion of the CPI. The broader housing component makes up a little more than 40 percent of the overall CPI. The major share of shelter costs is for rent-related components, the two largest series of which are owners' equivalent rent and residential rent; both are measures of cost for the use of shelter. Owners' equivalent rent (OER), discussed in greater detail below and in Robert F. Gillingham (1980), is essentially the amount a homeowner would pay to rent or would earn from renting his or her home in a competitive market. Residential rent (RR) measures the cost of tenant-occupied housing in a broad residential market. Pure rental components make up 20 percent of the CPI, and lodging components—hotels, motels, and school dormitories—add another 2 percent. It will be helpful in examining recent criticisms of these CPI series to understand the definitions and methodologies for calculating residential rent, owners' equivalent rent, and lodging-while-out-of-town data.

Rent of Shelter

Although the two largest subcomponents of the housing category, owners' equivalent rent and residential rent, each measure costs of what generally are considered different types of housing, they are more closely related than it might seem initially. OER is designed to measure the cost of renting the same type and quality housing as that occupied by homeowners, excluding utilities but including maintenance. Such housing is almost entirely single-family homes but also includes town homes. Residential rent measures the cost of rental housing and includes rents for many types of multifamily and single-family units. The unifying factor is that both measure the cost or use of a shelter service.

While some variety and range in the types of housing are represented in costs for owners' equivalent rent, the residential rent series covers a far broader spectrum of housing, and within this category rental housing having owner-occupied characteristics makes up only a portion of the tenant-occupied housing units. This overlap provides the key link between the estimation of residential rent and OER.

Data for both rent series come from the BLS housing survey, started in its current form in 1983 (with revisions in 1987).[7] The housing unit sample is stratified. That is, the sample is chosen to represent the various types of rental and owner-occupied housing in use at the survey date. It consists of approximately 40,000 rental units and 20,000 owner units. Each month only one-sixth of both the rental units and owner units are used to derive the CPI components. Each of the six panels is designed to be representative of the full sample. Either in person or by telephone, sample individual rental units are surveyed every six months and owner-occupied units are contacted once every two years. However, as discussed further below, characteristics of owner-occupied housing units—the panels—are used every six months.

Table 1
Expenditure Groups and Relative Importance
December 1992

Expenditure Group	Relative Importance
CPI, Total	100.000
Housing	41.404
Shelter	27.880
Renters' costs	7.993
Residential rent	5.801
Other renters' costs	2.192
Lodging while out of town	1.938
Lodging while at school	0.220
Tenants' insurance	0.033
Homeowners' costs	19.683
Owners' equivalent rent	19.303
Household insurance	0.380
Maintenance and repairs	0.204
Fuel and other utilities	7.280
Household furnishings and operations	6.243

Note: Official relative importance figures are published by the Bureau of Labor Statistics only for December of each year.

The BLS tracks rents for individual units as separate time series. BLS field agents gather from tenants, managers, or owners of rental units information on the current month's rent and the previous month's, and also on services provided. From owner-occupied units, they obtain an estimated or implicit rent, the amount for which the owner says the unit would rent on the market. Field agents also collect information on the characteristics of the housing units, including structure type, number of rooms, and the age of the unit. The sample is stratified, based on census information about neighborhood and average rent level (classified as high, medium, or low). Since a respondent's estimate of the implicit rent of owner-occupied units may not appear to be reasonable in comparison with similar housing, field agents are allowed to enter their own estimates, and the field agent's estimate is used.

A weighted-average process has been used to calculate the residential rent index since 1978. On the basis of housing survey data, changes are estimated (after adjustments for changes in quality) by calculating one-month-ago and six-month-ago percent changes for residential rent units surveyed in the latest month. The rental index numbers are moved by a weighted average of the one-month and six-month percent changes, with the one-month change getting a weight of 65 percent. Percentage changes are applied using stratified components. Rents are quality-adjusted for each month's aging of the units surveyed. The only changes in the process have been the selection of new samples, new sample-selection criteria, improvements in noninterview imputations, and updates in automation procedures for adjustments for quality change. Prior to 1978, the residential rent index was calculated by comparing the current month's rents with earlier rents over different time periods. Quality adjustments have always been made.

For owners' equivalent rent, the answers to the survey for implicit rent (including any adjustments by field agents) are important only for the initial estimate for each unit. After that is established, subsequent values of implicit rent for a given unit are derived by using changes in rent that occur in a specific subsample of the residential rent units used for the residential rent index. Essentially, the BLS computes changes in OER by using rent changes for housing units in the residential rent survey that have characteristics similar to owner units. A computerized selection process matches—by location, structure type, and other general characteristics—individual owner-occupied units with similar units in the residential rent sample. The BLS first looks for perfect matches and then, as necessary, relaxes constraints one at a time until a satisfactory set of renters' rental units is found for all owners. After the initial interview, owners' responses on housing characteristics become the important information because it is the match of housing characteristics to corresponding rental units that identifies which rental units will effect a change in OER.

Once the matching process is completed, OER is estimated in the same technical manner as residential rent. Even though owner units are contacted only every two years to check for quality and tenure changes, they are used in the matching process and index calculation steps every six months. In essence, a subset of the rental sample that best matches owner-occupied housing is used to estimate the owners' equivalent rent index.

There was a subtle change in this OER methodology in 1987. In the period from 1983 to 1986, when the BLS began using rental units in neighborhoods that were owner-occupied to estimate changes in the OER component, the rental units were not always of owner-occupied quality or characteristics; some units were apartments and other types of multifamily units, and the percentage they accounted for is unknown. In 1987 the BLS began sorting units specifically and confirming owner-occupied characteristics.

Definitional Differences in Rent. Measured rent covers different things for the OER and RR components of the CPI. Rent figures collected in the housing survey are on a contract basis for residential rent, and therefore might include utilities or other additional costs, but are on a pure rent basis for owners' equivalent rent. For residential rent, the contract covering specific housing units defines the changes in collected rents and in services provided. These collected rents include any labor involved as part of payment and all services and facilities provided on a contract basis, such as furniture or utilities. The pure rent basis for owners' equivalent rent focuses solely on the cost of renting shelter, excluding other items covered elsewhere in the CPI like utilities, insurance, and furniture. Owners' equivalent rent subtracts payment for the furniture and utilities if they are included in the rent estimates.[8]

Both rental components are adjusted for changes in quality. If there has been a major structural change in an owner unit, an appropriate adjustment is made in the level of rent. Adjustments are also made for changes in services and facilities provided by the landlord—for example, eliminating the inclusion of utilities in the rent or adding a room to an apartment. Beginning in 1988 the BLS also began to adjust rent for aging, which is viewed as reducing the quality of housing units. Table 2 summarizes the historical approaches to measuring home ownership costs in the CPI.

Residential rent and owners' equivalent rent are closely related in terms of how they are estimated. Each is payment for a service, and both are dependent upon the same survey data for their estimates. A later section will review how well each of the series corroborates related data series.

Lodging While Out of Town

The lodging-while-out-of-town component of the CPI is a very different rent measure from the OER and RR. For the purposes of this article it is, however, important to examine it because it is a rent component—measuring the cost of use of shelter—and its movement over the 1990-91 period diverged markedly from general expectations of what was appropriate for then-existing economic conditions.

The lodging-while-out-of-town housing subcomponent has an interesting history; recent methodological improvements have had a sizable impact on its patterns. This component essentially measures changes in lodging costs at hotels and motels and was first introduced into the CPI in January 1964. Movement in the index is based on rate changes for hotel and motel rooms rented for pleasure or family activities and excludes business, institutional, and convention use. Several specific characteristics are priced: the number of occupants, room location and number, type and number of beds, and amenities available (for example, telephone, television, and transportation). Taxes charged to the consumer are included as part of the total fees. These can include sales taxes, hotel/motel taxes, special facility and services taxes, and any taxes levied by special authorities for specific purposes, such as constructing and operating convention centers and tourist facilities.

The choice of geographic area covered by the series has been an important part of its methodology and has been a critical factor behind apparent changes in behavior. The recent acceleration in the component's rate of increase can be accounted for largely by the relaxation in geographic constraints for selection of hotels and motels in the sample. Originally and through 1986, quotes were limited to hotels and motels in the CPI's geographically defined pricing areas, the urban areas covered by the CPI. Before 1978, outlets (the establishments being priced) were selected from national travel directories for lodging and included national chain hotels/motels and individual, local facilities.[9] Starting in 1978, unemployment insurance files, which

Table 2
Historical Approaches to Measuring Homeownership In the Consumer Price Index

Time Period	Index Title	Home Purchase Used?	Other Homeowners' Costs in Index?	Index Used for Homeowners' Costs	Details
1. Pre-1953	CPI-W	No	Yes	Rent index	Cost and weights of home purchase, mortgage principal, capital improvements considered as investments and excluded. Weights for home maintenance, interest, taxes, and insurance moved by rent.
2. 1953-63	CPI-W	Yes	Yes	Separate items priced for homeownership	Home purchase added using weight of homes purchased during expenditure survey. Also added indexes for mortgage interest, incidental expenses, ground rent, taxes, repairs, and improvements.
3. 1964-77	CPI-W	Yes	Yes	Same as 2	New expenditure weights used.
4. 1978-82	CPI-U and CPI-W	Yes	Yes	Same as 2	New expenditure weights used, mortgage interest and FHA sample problems.
5. 1967-82	CPI-U X1	No	No	Rent index	CPI-U rerun excluding home purchase, mortgage interest, property taxes, property insurance, maintenance and repairs indexes. Rent index reweighted and substituted. X-1 started in 1980, now extends back through 1967.
6. 1983-86	CPI-U (and CPI-W for 1985-86)	No	No*	Owners' Equivalent Rent	Individual rental units reweighted by homeowner/renter ratio. Home purchase price, mortgage property taxes excluded.
7. 1983-84	CPI-W	Yes	Yes	Same as 2	Conversion to OER for the CPI-W occurred two years after CPI-U change.
8. 1987-present	CPI-U and CPI-W	No	No*	Owners' Equivalent Rent	Homeowners' implicit rents moved by change in matched pure rents. New weights and sample.

**Except for homeowner purchases of insurance, maintenance and repairs, and appliances, which are included and reweighted equal to renters.*

contain the names, locations, and number of employees for hotels and motels across the country, were used as the universe for selecting sample outlets to be priced, with the probability of being selected proportional to an establishment's number of employees. While the intent was to capture rates for travel and pleasure for consumers in the covered urban areas, lodging outlets were still restricted to those within the CPI urban areas and therefore did not necessarily reflect consumer rates in locations where consumers tended to vacation. In 1983 the method for selecting hotel and motel outlets began to change and when fully implemented would affect index movement. The new method changed from the CPI independent sourcing of hotel and motel outlets for pricing to that of the point-of-purchase survey (POPS)—the primary procedure for selecting sample stores and other retail establishments for the CPI program.[10] This survey is conducted by the Bureau of the Census for BLS.

To implement the new methodology for this lodging component, a hotel/motel category was added to the point-of-purchase survey. Many of the outlets identified by POPS were not located in the officially defined priced primary sampling units (PSUs) or urban areas, however, and their inclusion necessitated greater data collection costs. Nonetheless, because such areas are where the POPS households actually had lodging expenses, BLS shifted to POPS in order to access a more representative and more accurate sample for the lodging-while-out-of-town component.

With the 1987 revision of the overall CPI, the BLS gradually began using the POPS data for lodging while out of town by increasing yearly the number of pricing areas using only POPS data. Thus, no longer were hotels and motels limited to within twenty-five miles of the urban areas priced for the CPI, and outlets became eligible for the lodging sample regardless of their location in the United States. (The cost of lodging in foreign destinations by U.S. citizens is not covered in the figures gathered.) Pricing is done by telephone if the facility is too far away for field agents to visit.

Using POPS as an outlet source means that hotels/motels in the sample selected now fall primarily in tourist areas rather than in large cities, the focus being on the cost of lodging at the consumer destination. With more of the sample in beach areas, ski resorts, major attractions, and along interstate highways throughout the country's key tourist areas, the sample better represents actual consumer travel patterns.

Collection of Hotel/Motel Prices. The lodging-while-out-of-town component is priced monthly in the CPI. The rate sought is the lowest room rate available to such individuals, based on current occupancy levels on the day of collection. Thus, when occupancy is high, the "rack" or published rate may be obtained; when business is slow, below-rack rates are collected. Substantial seasonal price fluctuations often occur because many areas are frequented by vacationers primarily during summer and school vacation times.

Until May 1992 the sample included 152 outlets priced for lodging while out of town. These were spread over numerous locations reflecting the selected sample for each of the eighty-five pricing areas.[11] Necessarily, in any given area the sample size was somewhat limited. During the period from January 1987 to May 1992 the index therefore reflected price movement of a rather small sample, subject to volatile seasonal price movements, with prices reflecting the actual occupancy rates of each priced outlet. While monthly price changes (not seasonally adjusted) would be significantly affected by the volatile seasonal price movement, the year-over-year increase would largely reflect the underlying price movement in the sample outlets. As of June 1992, a new, substantially expanded sample, containing over 1,000 outlets, was put in place for all areas and will remain as the sample of priced outlets for five years. Outlets in this sample are also concentrated in vacation areas. Nearly 60 percent of the sample outlets are located in ten states.[12]

*R*ecent Trends and Explanatory Factors

Given the behavior of the rental components in the 1990-92 period, there is some reason for concern about whether or not CPI housing components accurately represent changes in consumer prices, especially considering the large shares that housing components, and even the rent subcomponents alone, have in the CPI. One important question is whether these rent components have diverged significantly from the prices they are intended to measure, and if so, why? Divergence may occur for several reasons. For example, there are times (such as during recession) when uncertainty about income gains dramatically reduces home purchases while maintaining or even boosting rental demand. In addition to income concerns, expectations concerning home prices can make home prices and rent diverge: if home prices are expected to rise sharply in the future, renters may buy now, thereby weakening rents.

Another question to consider is that of whether the divergences are consistent with other economic data. In other words, do various economic factors validate the methodology that produces these CPI series? In addressing this issue the relative behavior of the overall CPI and the residential rent and owners' equivalent rent components needs to be examined.

Residential Rent. Over the 1970s, increases in residential rent steadily accelerated from a 3 percent pace early in the decade to a greater than 9 percent rate by 1980, following much the same path as the overall CPI. Similarly, residential rent inflation rates declined sharply over the 1980-82 period before undertaking a roller-coaster downtrend throughout the rest of the 1980s and into 1992. During the 1990-91 period, both the overall CPI and residential rent component decelerated. However, the growth rate in the overall CPI slowed much more sharply than the residential rent component, as shown in Chart 1. Through mid-1992, while the CPI inflation rate leveled off, the residential rent rate continued to decelerate.

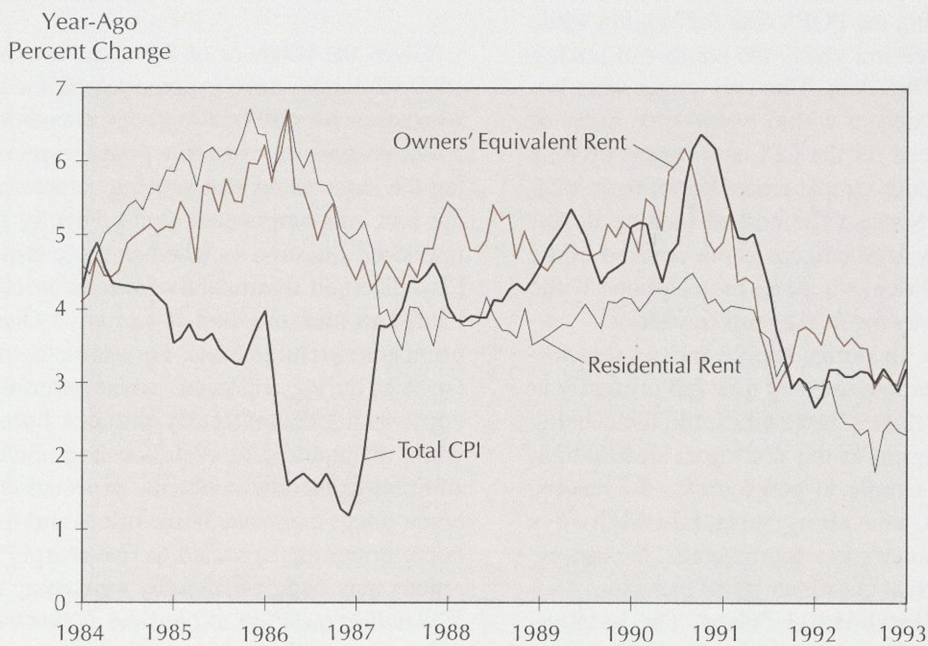
At first glance, this pattern is somewhat puzzling because other economic indicators suggested that rents should have been their weakest in the 1990-91 time frame. One might argue that rent should have been affected by the downtrend in inflation expectations as much as the overall CPI was. Furthermore, purchased homes and rental shelters may be viewed as close substitutes, so that home prices and rent were expected to move together. However, existing home prices were weak from 1990 into 1991. New single-family home prices were especially low and remained so over a longer period, from 1989 to 1992. During the 1990-91 period, the multifamily sector was still overbuilt, with multifamily vacancy rates remaining high. Given the recession and the depressed real estate sector, the CPI residential rent component and owners' equivalent rent series appeared to be out of line with housing market conditions.

From mid-1990 through mid-1991, the overall CPI inflation rate fell from over 6 percent to under 4 percent (and decelerated even further into 1992). For that period, residential rent's inflation pace slowed from 4 1/2 percent to 3 percent. While the rate of inflation was lower, the magnitude of deceleration was not as great as for the overall CPI.

There are a number of explanations for this divergence in CPI component trends that do not focus on rental pricing. For example, oil price weakness was a factor in the overall CPI's greater disinflation. Nevertheless, the divergence of housing costs from general index behavior warrants explanation.

Because owner-occupied housing and rental housing are substitutes, simple economic theory suggests that their prices should move together. An important

Chart 1
Total CPI, Residential Rent, and Owners' Equivalent Rent



factor in home and rental prices, however, is that a home purchase represents more than a purchase of services. Rent and housing prices are indeed affected by some common elements, but there are also a number of factors that affect each independently.

Rent is generally considered payment for housing services (shelter) provided. In contrast, when purchased by an owner-occupant, a home represents both a financial investment and the buying of shelter services. Home prices are determined by a mix of supply and demand for both investment opportunities and for the housing services. However, home prices in the short run are dominated by relatively fixed supply and large swings in demand that are interest rate related. Basically, home prices reflect a small percentage of the housing stock that is priced infrequently, and rent reflects a larger pool of housing units being priced often.

Because rent and housing prices are not determined by exactly the same factors, there is really no reason to expect that these prices would always move together in lockstep. The major factor tying the two together is the housing services portion of the value of a house, separate from its investment value. For a number of reasons, this factor does not keep rent changes completely in tandem with changes in housing prices. For one thing, the consideration of housing as an investment cannot be completely separated. The most important factor behind the differences, though, is that demand is very different for each, yet near-term supply for both is relatively fixed. As mentioned above, in times of economic uncertainty and high interest rates, buyers tend to withdraw from the home market while the market for rental housing remains more stable. It is also significant that there are constraints on consumers in terms of freely moving back and forth between renting and purchasing homes—the cost considerations of moving, for example. An additional factor is that not all renters can qualify to purchase a house or have adequate savings for down payments.

Rational shifts in households' demand for rental housing and purchased housing, caused largely by expected changes in housing prices, can partly explain near-term divergence in rents and housing prices if rental housing is recognized as having a purchase option. Just as homeowners have a prepayment option and can profit when interest rates decline, a renter can exercise the option to break a lease and buy a home when expected, discounted future home prices significantly exceed their current market value. In other words, if housing prices were expected to rise more rapidly than other asset prices, then renters would be more motivated to get out of their lease and purchase a home, thereby reducing demand for rental housing and weakening rents. On the other hand, if housing prices were expected to decline, renters would have incentive to defer a home purchase, and such a decision would help support the level of rents.

Finally, another important reason that rent changes occur less frequently and with a built-in lag compared with changes in prices for houses on the market is that rents primarily change when occupancy changes or long-term leases expire. These differing functions of rental and owner-occupied housing suggest that while rent and housing prices should be related through their purchase of housing services, it is reasonable that they diverge at times. The delay in the rental market's adjustment to other forces is understandable given the restraints on charging new rents.

What about the data's indications in terms of how closely CPI rental components are related to various other economic factors? Many factors affect residential rent, home prices being only one; vacancy rates as a measure of supply, wages as a measure of demand, and the small percentage of turnover in rental markets also cause average rents along with the CPI rent series to change slowly. The focus here is on whether the movements in residential rent have been consistent with the economic factors. A simple statistical model is used to see whether these variables explain rent movement and whether they confirm or refute the allegation that this CPI component is flawed. Charts 2 and 3 show the behavior of home prices and vacancy rates relative to changes in residential rent.

The model uses monthly year-ago percent changes for residential rent, the dependent variable, as well as for median sales prices for existing family homes, one of the explanatory variables. The multifamily vacancy rate, left unchanged in its simple percentage form, is estimated over the January 1970 through December 1989 period (subsequent months are the ex post forecast period) using the Almon distributed lag technique. This technique allows the explanatory variables to affect residential rent CPI gradually rather than all at once. With the Almon technique, an independent variable can be entered into the model as a variable spread over several periods in the past. Each period adds up to form a cumulative impact on the dependent variable.[13]

The regression results shown in Table 3 indicate that existing home prices and multifamily vacancy rates do a fairly good job of explaining changes in the growth rate of residential rent CPI. The adjusted R^2 is 0.77, and the fitted values (the ex post forecast) track this CPI component reasonably well. The coefficients of the independent variables are as expected, with the housing price variables having a positive sign for the sum of the lag coefficients while that same sum for the vacancy rate is negative. Essentially, this result means that as housing prices accelerate, residential rent inflation goes up, and as vacancy rates rise, rent inflation declines.

What does this model suggest about the expectations for the rate of residential rent increase over the 1990-92 period given the other variables? As shown in Chart 4, the ex post forecast closely tracks actual data until late 1991; the actual data are only slightly higher than projected over much of the year. But at the end of 1991, the forecast (the implicit "appropriate" rate of increases based on the independent variables) exceeds and diverges sharply from the actual. The jump in the forecast can be accounted for by the lagged effects of sharp increases in housing prices. The residential rent CPI was in line with these explanatory variables over most of 1990 and 1991 but according to this model was too low in early 1992. In early 1992, according to this model the lagged effects of 1991's strong housing prices caused by lower interest rates should have kept residential rent higher than BLS reported. However, while the economy was strong enough in the housing market to boost home prices temporarily, it was too weak to create large rental gains. These higher housing prices raised the ex post forecast relative to actual values.

Owners' Equivalent Rent. Owners' equivalent rent decelerated along the same path as the overall CPI from mid-1990 through mid-1991, as seen in Chart 1. The OER inflation rate slowed from a 6 percent pace to 3 percent within twelve months. In 1992, however, the OER inflation rate rose back up to 3 1/2 percent and even briefly to almost 4 percent even though housing price increases slowed in the second half. The key question is whether or not the 1992 surge was appropriate given the economic conditions, yet the possibility of problems with the OER index in 1992 cannot be separated from the 1990-91 deceleration. Were the OER data consistent with economic conditions over both periods?

It is inevitable that price index data temporarily diverge from fundamentals. Conceptually, implicit rents are measured by the movement in fair market rents, which can temporarily diverge from changes in prices for homes as an asset. Rents can continue to increase while house prices fall until vacancy rates and cheaper owner-occupied housing restore the equilibrium. Because OER tracked the overall CPI during the 1990-91 period, because the overall CPI rate was pulled down by the energy component, and because OER should not have been as affected by oil price declines given that utility bills are separated from rent payments, it is

Chart 2
Single-Family Home Prices versus Residential Rent

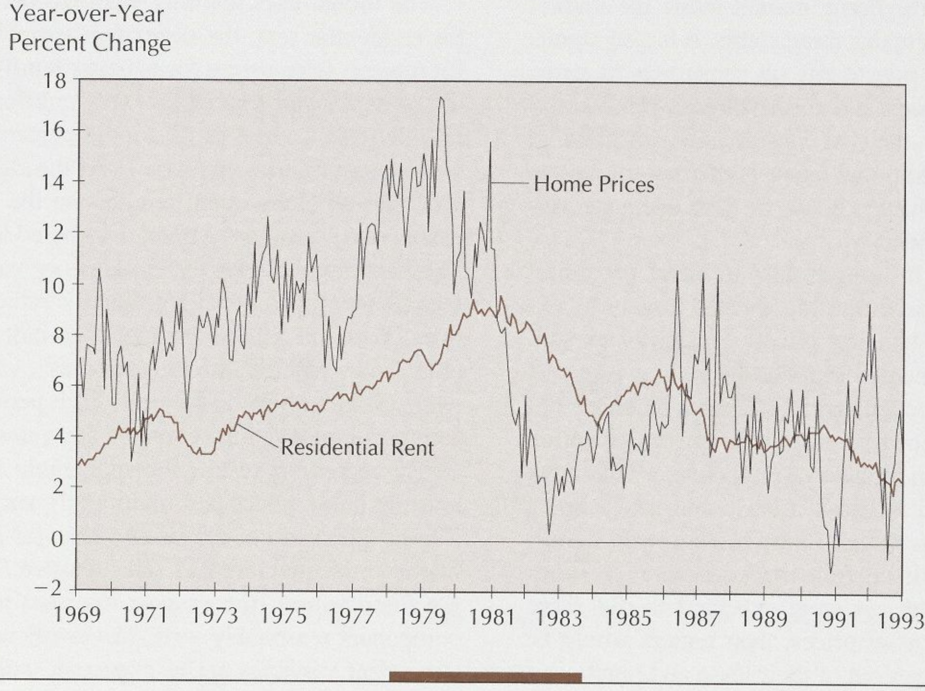


Chart 3
CPI Residential Rent versus Multifamily Vacancy Rates

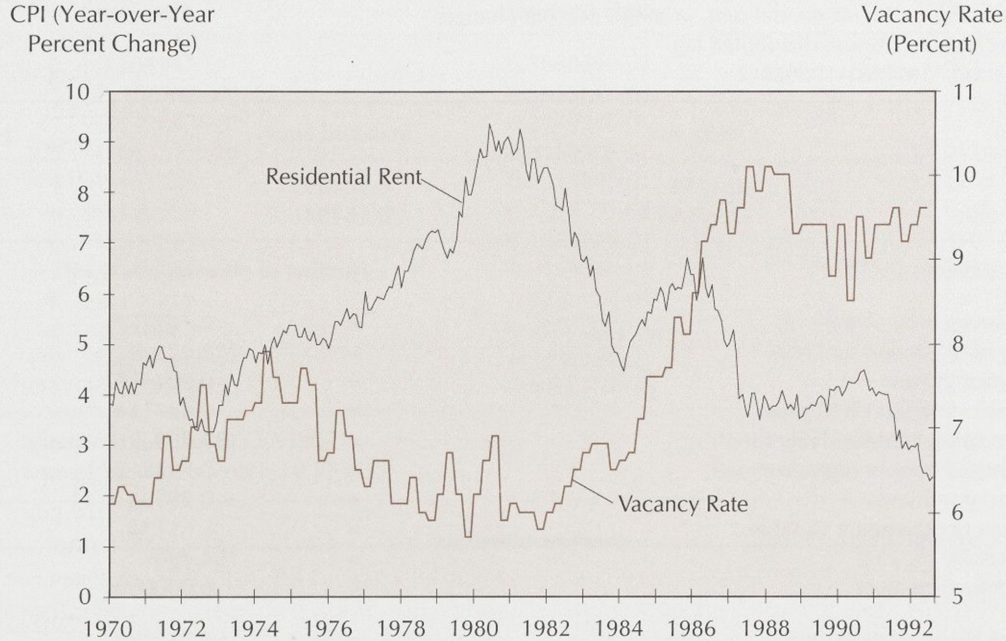


Chart 4
CPI Residential Rent, Actual versus Forecast

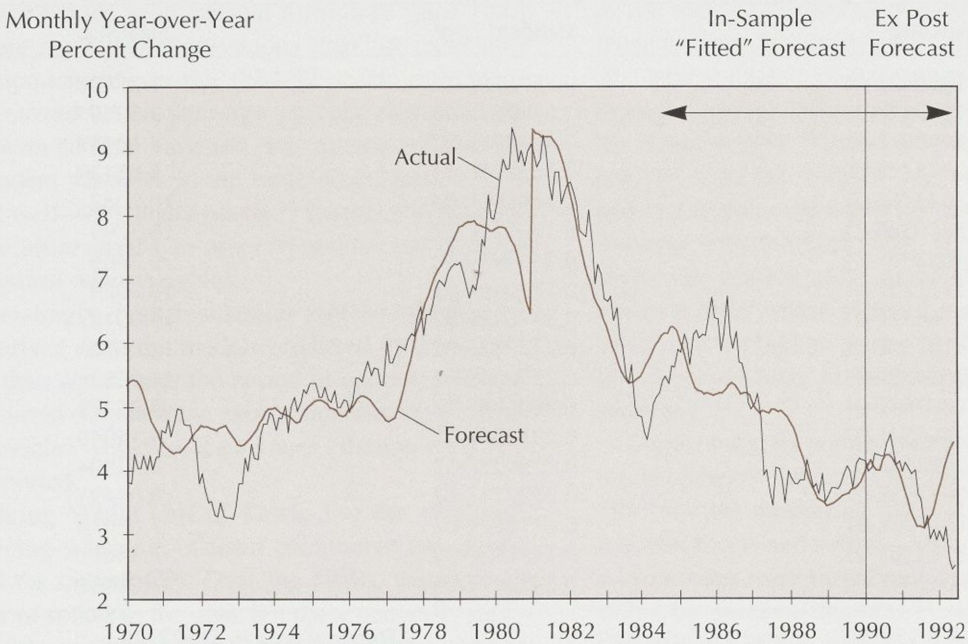


Table 3
Regression Model for CPI Rent

Dependent variable: CPI, residential rent, year-ago percent changes
Regression technique: Almon distributed lag
Estimation period: 1970M1-1989M12

Variable	Coefficient	Standard Error	*t*-statistic
Constant	10.1754	0.404999	25.1246
Dummy Variable	–2.97664	0.154941	–19.2115

R-squared = 0.778510 Number of observations = 240

R-bar-squared (Adj for df)	=	0.773777
Log of likelihood function	=	–270.221
Durbin-Watson	=	0.204517
Durbin-Watson (4) (0 gaps)	=	0.687114
Sum of squared residuals	=	133.567
Standard error of regression	=	0.755512
Sum of residuals	=	–0.295053E-11
Mean of dependent variable	=	5.61154
F-statistic (5, 234)	=	164.496
Significance level	=	0.000000
Root mean squared error	=	0.742230
Mean absolute error	=	0.571414
Mean error	=	–0.153197E-01

Lagged, distributed variable: Existing housing prices, median, year-ago percent changes
Distributed lag interpretation

	Coefficient	Standard Error	*t*-statistic
0	0.109842E-01	0.797078E-02	1.37806
–1	0.158062E-01	0.631781E-02	2.50185
–2	0.199891E-01	0.483425E-02	4.13489
–3	0.235329E-01	0.353751E-02	6.65239
–4	0.264376E-01	0.246890E-02	10.7082
–5	0.287032E-01	0.173120E-02	16.5799
–6	0.303298E-01	0.149504E-02	20.2869
–7	0.313173E-01	0.172046E-02	18.2029
–8	0.316657E-01	0.211084E-02	15.0015
–9	0.313750E-01	0.247792E-02	12.6618
–10	0.304452E-01	0.275045E-02	11.0692
–11	0.288763E-01	0.290104E-02	9.95379
–12	0.266684E-01	0.291764E-02	9.14040
–13	0.238214E-01	0.279428E-02	8.52504
–14	0.203353E-01	0.252771E-02	8.04493
–15	0.162101E-01	0.211601E-02	7.66070
–16	0.114458E-01	0.155797E-02	7.34662
–17	0.604244E-02	0.852811E-03	7.08532

Mean lag = 8.15979 Standard error = 0.602371
Sum of lag coefficients = 0.413986 Standard error = 0.209571E-01

Lagged, distributed variable: Multifamily vacancy rates
Distributed lag interpretation

	Coefficient	Standard Error	t-statistic
0	0.104941	0.568049E-01	1.84739
−1	0.371062E-01	0.381561E-01	0.972484
−2	−0.199847E-01	0.222058E-01	−0.899977
−3	−0.663321E-01	0.946030E-02	−7.01163
−4	−0.101936	0.595388E-02	−17.1209
−5	−0.126796	0.126735E-01	−10.0048
−6	−0.140913	0.182749E-01	−7.71073
−7	−0.144286	0.215356E-01	−6.69992
−8	−0.136916	0.223071E-01	−6.13779
−9	−0.118802	0.205505E-01	−5.78100
−10	−0.899452E-01	0.162510E-01	−5.53473
−11	−0.503443E-01	0.940205E-02	−5.35461

Mean absolute lag = 5.96596 Standard error = Undefined
Sum of lag coefficients = −0.854210 Standard error = 0.476799E-01

appropriate to question whether the OER deceleration in 1991 was excessive. Or perhaps the 1992 acceleration was an offset to excessive weakness in 1991. Were the 1992 data simply flawed, or was there an unexpected lag in the economic conditions further influencing OER? In examining these questions, a very basic problem surfaces in terms of validating the OER series: the index has existed in its present form only since 1983, and there are fewer observations than for residential rent. Importantly, over the 1984-92 period little variation occurred in the year-ago percent changes until 1990. With so little variation, any number of possible independent variables in the same model would work equally well—or equally poorly.[14] Essentially, there are too few observations to properly model and evaluate OER against other variables.

Interestingly, both residential rent and OER forecasts derived from the models predicted inflation rates higher than actual over the period of concern. This result occurred despite some expectation that the explanatory variables would forecast lower inflation rates than BLS reported.

Lodging While Out of Town. For the most part, the lodging-while-out-of-town component has closely tracked the overall CPI. Over the 1980s, there were a number of spikes in the data, but these generally represented rate increases being phased in during the off-season. Seasonal factors, which anticipated seasonal declines when rates might have actually been flat, boosted the seasonally adjusted numbers. However, the cause behind the very large increases for this CPI component in 1990 and into 1992 is different from the demand factors causing the rate of increases in previous years (although the large gains probably were also exaggerated by seasonal factors).

Starting in August 1990, the twelve-month change of the lodging-while-out-of-town component jumped from 7.3 percent in July to 13.4 percent in August. The twelve-month changes remained in double digits through October 1991, reaching a high of 21.4 percent for January 1991. These unexpectedly large increases resulted from the shift by U.S. vacationers from international to domestic travel because of crisis abroad associated with the Gulf War. This shift in demand to domestic vacation areas, particularly to popular U.S. vacation areas where many of the POPs outlets are located, led to higher prices in these locations while leaving hotel rates little changed in business district locations.

Importantly, as pointed out earlier, the BLS shifted the geographic coverage for the hotel/motel series in 1987 toward measuring rates at resort and vacation-location hotels and motels. Also, over the 1990-91 off-season, rates were raised and the increases were magnified by seasonal factors. However, the hotel/motel CPI was out of line with some industry statistics.

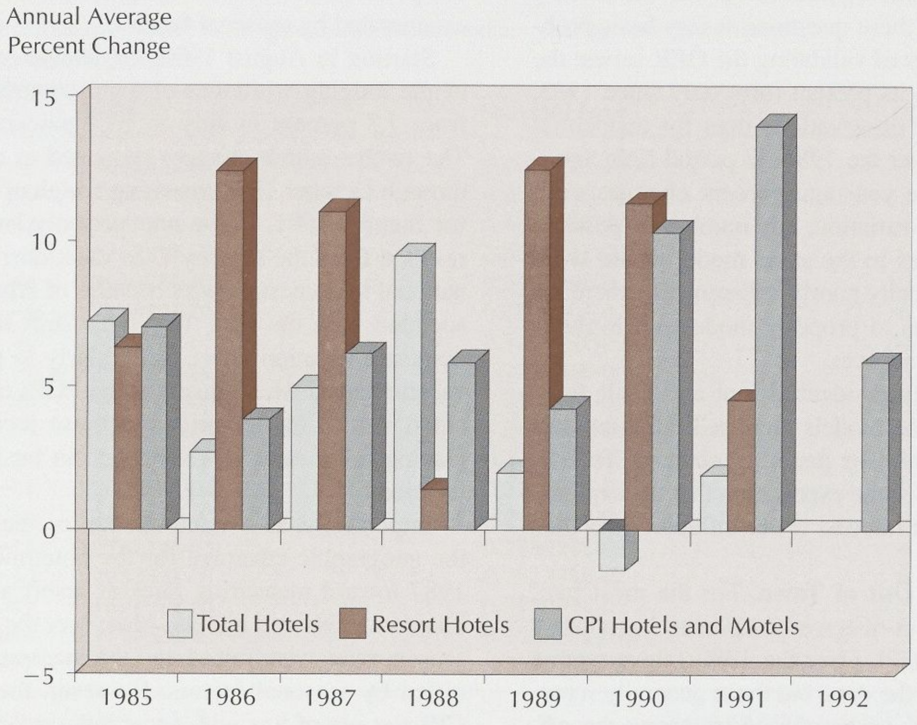
For comparison purposes, industry data for this study were obtained from Pannell Kerr Forster Consulting in San Francisco, California. Annual averages were available for both the overall hotel industry and for the narrower resort segment of the industry.[15] Indeed, hotel rates for the overall hotel industry were weak in 1989 and even declining in 1990 (see Chart 5). These figures include corporate rates, however, as well as pleasure rates and rates for hotels away from vacation areas and resort areas. In contrast, fees at resort hotels posted sizable increases in 1989 and in 1990, with a more moderate rise in 1991. These figures corroborate the surge in the hotel/motel CPI as being caused primarily by the change in geographic coverage. Taking into account that the Pannell Kerr Forster data for resort hotels captured rate increases a year earlier than the BLS data, probably because of differing calculation methods, this CPI component has been consistent with the appropriate, narrowly defined, industry data.[16] Essentially, this CPI series never measured rates for the overall hotel industry and currently should not be construed as doing so.

Conclusion

Though there have been serious attempts to make them straightforward measures of the costs of housing services, both OER and residential rent in the CPI implicitly contain prices of services other than shelter. Each series is affected by consumer behavior in response to current income, expected income, and current and expected prices for shelter alternatives—owned and rented. This consumer behavior limits the tightness of the relationship of OER and residential rent over time and causes each to behave in ways that are inconsistent with analysis based purely on their shelter functions.

Nevertheless, despite concerns to the contrary, movement in CPI rental components from 1990 to 1992 were not inconsistent with shelter-related economic data. After taking into account appropriate lag times, the CPI for residential rent (tenant-occupied) was strongly

Chart 5
Hotel and Motel, CPI versus Industry Estimates



Source: Data on "total hotels" and "resort hotels" are from Pannell Kerr Forster Consulting, San Francisco.

correlated with housing prices and multifamily vacancy rates over the same period. Although owners' equivalent rent was at best weakly correlated with these variables, an understanding of the index's methodology suggests that one should not expect such relationships to be tight. Owners' equivalent rent did lag residential rent over the 1990-92 period in the same manner in which it had over the 1983-1989 period. Given that the current OER series is relatively new, it is too soon to conclude on a statistical basis whether or not its methodology is consistent with shelter-related economic data. Finally, OER and RR cannot be expected always to move together because each series is based on different types of structures.

The hotel/motel CPI component no longer has earlier geographic restrictions, with the result that this component primarily tracks consumer hotel/motel rates in key resort areas. This newly defined hotel/motel component has been consistent with narrowly (but appropriately) defined industry data on rates at resort areas. It is with overall rates for hotels during the 1989-91 period that there is an apparent discrepancy. Such a broad comparison, however, is not appropriate for critiquing the methodology of this price index for consumers. Taking into account changes in methodology, the movement in residential rent and in the hotel/motel CPI is readily explainable by economic conditions.

Notes

1. See, for example, Wallich and Corcoran (1989), Davies (1992), and Madigan (1991).
2. Pollin and Stone (1991) and Madigan (1991) discuss the basis for these concerns.
3. Lodging while at school is the final rental component in the CPI, but it has a very small weight in the CPI and is not discussed in this article.
4. This article examines data from the all-urban index (CPI-U), which covers a broader population base than the CPI for urban wage earners and clerical workers (CPI-W). The all-urban data are more closely followed.
5. The 1982-84 period is used as the base period because of timing factors involved in meeting the deadline for a December 1986 revision for the CPI. Three years of CES data are needed to derive the component weights, and the 1982-84 data were the most recently processed CES data available.
6. Component weights and relative importance are different concepts. Weights refer to base-year shares of components in the CPI—essentially the fixed real (inflation-adjusted) amounts of a good or service in the market basket in the base year. Relative importance reflects the share by expenditures for a component of the CPI in any given period as component price changes diverge. The relative importance of components with inflation rates that are higher than the average rises over time. Their share in the index expands because of relative price changes over time, not because of any change in the base-year weight. Weights are changed only when the CPI is redefined, but relative importance changes whenever prices for components change at different rates.
7. From 1953 to 1983 the shelter component was based on the cost of purchasing housing and included a mortgage rate component. The shelter component—and, it can even be argued, the overall CPI—is essentially a new series starting in 1983 because of these changes in definition.
8. Price changes for these costs appear in separate CPI series.
9. Selection was based on an outlet's probability of being selected, which is proportional to its number of rooms.
10. It may be helpful to provide an overview of the various surveys used as inputs into the CPI. (1) The Consumer Expenditure Survey is used to determine expenditure weights for CPI components. (2) The Continuing Point-of-Purchase Survey (CPOPS, or POPS) is used to determine which outlets are to be priced. (3) The CPI survey actually selects and prices the goods and services. (4) Housing units are selected from information provided by the 1980 Census, combined with an on-going new construction permit sample.

    The point-of-purchase survey is a household interview survey conducted to obtain the names and addresses of outlets by defined categories of purchase. The survey also obtains the amount of the household's expenditure at each outlet for each purchase category. By category, outlets are selected for pricing using probability proportional to the reported expenditure.
11. Samples reflect priced outlets as of February 1992. Actual outlets priced vary, as one-fifth of the pricing areas have their samples reselected each year. The states accounting for the largest number of outlets for the samples used to measure price movement through May 1992 and their percentage of the sample are as follows: Florida, 17.3; California, 7.7; South Carolina, 5.6; Virginia, 5.2; Hawaii, 4.8; Nevada, 4.8; Illinois, 3.6; New York, 3.2; North Carolina, 3.2; and Washington, 2.8.
12. The ten states and their percentages are Florida, 19.2; California, 10.7; Nevada, 5.4; Hawaii, 4.6; New York, 3.8; Texas, 3.7; Virginia, 3.2; North Carolina, 3.1; South Carolina, 3.1; and Tennessee, 3.0. This expanded sample obviously differs somewhat from the pre-June 1992 sample and could be responsible for a portion of any change in behavior in this CPI series.
13. After some experimentation with the lag structure, the price variable coefficients were estimated with a second-order

polynomial distribution for the lag coefficients and a lag period of eighteen months, including the contemporaneous month. The order of polynomial distribution refers to the shape of the constraint on the coefficients of the lagged variable. An n order polynomial distribution has $n - 1$ inflection points, and so the second-order constraint means that the coefficients follow a simple rising and falling curve. The vacancy rate variable also was assigned a second-order polynomial structure but with a lag length of twelve months. Also, because of an apparent shift in the relationship between CPI residential rent and home prices, a dummy variable was introduced into the model.

The dummy variable is set to 1 for the January 1970 through December 1980 period and is set to 0 for all subsequent months. Over the earlier period, growth in home prices was consistently higher than for residential rent. Thereafter, the two inflation rates are much closer. It is unknown what causes this apparent and sharp shift in home price trends relative to residential rent CPI. The discontinuity could reflect any type of factor, ranging from demographics to changes in financial regulations. The dummy variable is added to the model solely for the purpose of letting the more recent data (post-1980) have more impact on the forecast period. Adding the dummy variable to the model reduces the importance (magnitude) of the constant term and allows the coefficient of the other variables to play larger roles in the forecast. However, leaving the dummy variable out does not affect the implications of the model. The goodness of fit is lowered only modestly.

14. In fact, over the 1984-89 period, there is such limited variation in the dependent variable that the independent variables in a regression (not shown) using housing prices and vacancy rates have the wrong sign (also indicating some multicollinearity problems). Extending the regression estimation period through 1991 increases the variation in the dependent variable and gives more reasonable results for the coefficients. However, these variables do little to explain movement in owners' equivalent rent. The adjusted R^2 is low at 0.17.
15. Pannell Kerr Forster Consulting surveys hotels in the United States for a variety of information, including hotel characteristics, accommodations, revenues, and room rates. Questionnaires are sent to management companies, owners, and operators. Pannell Kerr Forster regional offices compile the statistics and forward them to the San Francisco office. Respondents classify themselves according to a number of hotel categories: conference center, resort hotel, full-service hotel, limited-service hotel, suite hotel, and convention hotel. Pannell Kerr Forster defines a resort hotel as a hotel, usually in a suburban or isolated rural location, with special recreational facilities to attract pleasure-seeking guests. The survey sample covers roughly 1,000-1,200 hotels, with about eighty classified as resort hotels. The quotes for hotels overall and for resort hotels are average daily rates per occupied room. Pannell Kerr Forster does not hold constant the type of room.
16. Pannell Kerr Forster data are based on yearly revenues divided by rooms. BLS figures are derived from averages of separate monthly estimates.

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Review Essay

Capital Ideas: The Improbable Origins of Modern Wall Street

by Peter L. Bernstein.
New York: The Free Press, 1992.
340 pages. $24.95.

Thomas J. Cunningham

Do you beat the market? William Sharpe, who would eventually win the Nobel prize in economics for work centered on this very question, asked the question in the mid-1960s over lunch with Peter Bernstein, a mutual-fund manager. Bernstein talked about his performance relative to other fund managers and the Dow. Sharpe interrupted, asking again, "But do you beat the market?"

At the time, it was tough to tell. No one had ever really asked the question before. "The market" was an ill-defined term, and its return was not well measured. Bernstein may have beaten the Dow, but Sharpe was more interested in the total return from a very broad market, not just the price appreciation of an index of a small, albeit well-known, number of stocks.

Things have changed. Finance, in both theory and practice, has undergone a spectacular transformation in a relatively short and recent period. Peter Bernstein traces the history of finance and finance theory—essentially the last thirty years—in *Capital Ideas: The Improbable Origins of Modern Wall Street*.

Although any historical account, particularly one of ideas, is bound to reflect the personal experiences and prejudices of its author, the chronicle of financial theory and innovation in *Capital Ideas* is, in large measure, a recounting of the author's personal experience. Bernstein, who is acquainted

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with both the theoretical and applied sides of finance theory, has been in and around financial markets throughout his adult life. He did not need to second-guess the intent of the historical figures in his narrative; he simply talked to them. Despite this personal perspective, his prose at times seems aimed a bit too high for the general public. Those with an interest or experience in finance, however, are likely to find a large part of the book informative and interesting.

The text is divided into six parts: The single-chapter introduction and conclusion bracket four multichapter sections that develop specific topics. Within each section and from section to section, topics are treated more or less chronologically.

Cowles and the Efficient Markets Idea

Bernstein begins his history of finance theory with a simple explanation of the efficient markets idea—that is, why excess stock returns are unforecastable. While this theory now seems innocuous, early (and even not so early) in this century the proposition annoyed many employed in financial markets, especially those who made their living as investment advisors.

The first discrete character in Bernstein's historical narrative is Alfred Cowles, who set out in the 1930s to see how well investment advisors actually predicted market performance over time, something that had never been done before. The effort proved problematic: tracking several thousand recommendations made by selected investment firms and advisors and comparing their performance against that of the market as a whole was a straightforward but mammoth task.

Two things came of Cowles's efforts: first, the Cowles Foundation, which he established to promote the efforts of scholars interested in combining economics and statistics; second, his results, which showed that, over the period examined, the best investment advisor selected stocks whose yields were about half as much as the market as a whole. Not surprisingly, these results were not warmly received by the investment advisor community.

The Risk-Reward Trade-Off

Bernstein next focuses on the idea of the trade-off between risk (which Cowles did not consider) and reward and the appropriate way to measure each. He also offers some personal insight into how these ideas were accepted—or, early in the process, vigorously resisted—by portfolio managers.

Even though Cowles's work was widely available, little came of it for two decades, in part, Bernstein argues, because finance had not developed as an academic discipline. Bernstein illustrates this point with a story about the work of Harry Markowitz. When Markowitz (an eventual Nobel laureate) defended his doctoral dissertation on portfolio selection at the University of Chicago in 1952, faculty committee member Milton Friedman (another future laureate), said, "'Harry, I don't see anything wrong with the math here, but I have a problem. This isn't a dissertation in economics, and we can't give you a Ph.D. in economics for a dissertation that's not economics. It's not math, it's not economics, it's not even business administration.'" The committee did, however, come around.

Markowitz's contribution to finance, in a gross simplification, was to show that risk in a portfolio can be contained through diversification: though each individual asset in the portfolio may be risky, the risks need not be correlated among the assets. Thus, a diversified set of assets may jointly be less risky than the assets in the portfolio taken individually.

The idea of portfolio diversification was further developed by James Tobin, who took over the Cowles Foundation and moved it to Yale. In a 1958 article that was ultimately central to his winning the Nobel prize, Tobin emphasized portfolio diversification across a variety of different types of assets as the appropriate response to risk. That is, diversifying with a variety of risky assets may reduce a portfolio's combined risk. Tobin's work still serves as a standard of the finance literature. Bernstein shows how far removed the theoretical side of finance was from the practical application when he reports Tobin as saying, "'I am unique in that no real world financial enterprise has ever asked me for any advice whatsoever.'"

This section of *Capital Ideas* concludes with a chapter focusing on William Sharpe, whose question at the beginning of this essay originally challenged Bernstein. In 1964 Sharpe developed the empirics behind the capital asset pricing model (CAPM). The model formalizes the risk-reward trade-off by claiming that returns to assets should be a function of risk as measured by, in Sharpe's work, their relative volatility. Of course, recently, single-explanatory-variable models of almost anything, asset returns in particular, have fallen out of favor. Sharpe's work, however, would enable investment professionals like Bernstein eventually to answer the question, Do you beat the market? in a more systematic (risk-adjusted) way than did the simpler work of Cowles.

To measure just what "the market" was doing, Sharpe undertook a comprehensive accounting of returns to broad measures of securities markets, a formidable task in the 1960s environment of limited data bases and slow, expensive computers. Sharpe's work was similar to Cowles's not only in the size of the task but also in its results: Professional investment managers systematically underperformed the market as a whole. One could outperform investment professionals simply by buying "the market" and holding on. Bernstein argues that such results partly account for the problem in having academic work in finance accepted in the professional investment management community.

Technical Analysts versus Efficient Markets Gurus

In the book's third section Bernstein develops the efficient markets ideas in the area of stocks' price behavior and the particular notions of their apparently random character. He starts with a discussion of the initial questions raised about the foundations of technical analysis, which identifies patterns emerging from price behavior (typically of stocks or commodities) and tries to match the current patterns with those of the past to predict the future. What are now called efficient markets theorists, however, see a kind of catch-22 problem in technical as well as fundamental analysis; if one were truly able to discern tomorrow's price from past patterns, then, in hopes of making a profit, one would today bid the price of a stock up or down to tomorrow's price. That is, if tomorrow's price is known for certain, today's price will move to match, eliminating the potential certain profits. In short, technical market analysis and the efficient markets theory do not mix.

The initial attacks on technical analysis, however, came not from the financial theorists but from applied statisticians. In any random behavior, they argued, one can, after the fact, discern certain patterns. Inevitably, these patterns will repeat, but any apparent trend is illusory. Such repetition is no different from any random process observed closely and over a long enough period. In a truly random process, a "technical analyst" will be able to call the next day correctly about half the time; so, over time, might a coin.

Paul Samuelson, the first American Nobel laureate in economics, practiced his beliefs in a buy-and-hold strategy during his many years as a trustee and member of the finance committee of the College Retirement Equities Fund, a large pension fund for college teachers. Samuelson, firmly in the efficient-markets camp, did not think portfolio managers performed any real service. In an article in the inaugural, fall 1974 issue of the *Journal of Portfolio Management* (of which Bernstein was the founder and first editor) Samuelson expressed his scorn for portfolio managers:

> They also serve who only sit and hold; but I suppose the fees to be earned by such sensible and prosaic behavior are less than from essaying to give it that old post-college try. . . .
>
> But a respect for evidence compels me to incline toward the hypothesis that most portfolio decision-makers should go out of business—take up plumbing, teach Greek, or help produce the annual GNP by serving as corporate executives. Even if this advice to drop dead is good advice, it obviously is not counsel that will be eagerly followed. Few people will commit suicide without a push.

The section concludes with a chapter on Eugene Fama, whom I think of as the current dean of the efficient markets theorists. Fama's work beginning in the mid-1960s led to the now-prevalent view of the efficient markets literature that news—surprising news—is the primary factor responsible for moving securities prices. Securities analysis may have a role in gathering and disseminating information, and without this activity markets may not be as efficient as they otherwise would be. The possibility of gaining anything other than a short-term advantage from such analysis, though, either in information or some clever trading strategy, is remote.[1]

A Class in Corporate Finance

The fourth section of *Capital Ideas* discusses the development of what are now some of the basics of standard corporate finance classes. While most of the section looks at finance from the buyer's side (how to structure portfolios) the first chapter of the section considers the security seller's perspective—how should a corporation finance itself? On the corporate side, probably the most startling theoretical innovation to come from finance is the Modigliani-Miller theorem, developed in 1958. Modigliani and Miller (Nobel laureates both, though separately) asked whether the structuring of a company's balance sheet—that is, whether the company finances itself by selling debt (borrowing) or selling equity (stock)—matters. The Modigliani-Miller theorem answers the question negatively; whether financing comes from debt or equity is irrelevant for the firm's owners. The project to be financed will have some payoff to the current stockholders whether they have split that payoff with additional stockholders or additional bondholders. Institutional complications (for example, tax considerations) may lead current equity owners to prefer one means of financing to another, but without these frictions the choice of issuing equity or debt is a toss-up. If the overall project is worthwhile, the market will increase its valuation of the company.

The remaining chapters in the section, in a return to the financial market perspective, discuss a generalization of the capital asset pricing model and options pricing models. The chief problem with the CAPM, as noted above, is that it relies on a single-factor risk to explain asset returns. Arbitrage pricing theory, developed in 1976 by Stephen Ross, extends the CAPM to include a variety of a given security's attributes as factors that can explain its return. Finally, Bernstein describes the development, in 1973, of the Black-Scholes model—which explains an option's price as a function of the underlying stock's price, volatility, the rate of interest, and the time to expiration of the option—and the growth of its acceptance.

From Academe to Application

By this point in the book, the reader is well up on current finance and events. Black-Scholes calculations are routinely performed in real time on exchange floors. Buy-and-hold is a recognized and valued investment strategy. Indexes and technical data services that show how various market measures are performing over time have proliferated. Financial theory has found its way into the practice of finance, and now it is time for the financial theorists to follow. Bernstein describes this process in the book's final topical section, titled "From Gown to Town."

The section's first chapter discusses Wells Fargo Bank's entry into index funds in 1971. (Banks are not now permitted to offer this sort of security.) The bank's strategy was to combine the "best," most diverse portfolio to be had (the market as a whole) with the "best" management strategy (buy-and-hold). By any standard of fund performance, Wells Fargo did quite well with this plan. Strategists at Wells Fargo brought together financial academics and combined them with computers and money to create index funds through which investors could participate in the returns associated with financial markets indexes. This venture, detailed by Bernstein, was a triumph for Wells Fargo, which at the time took a considerable risk, and for financial theory and theorists. Whatever resistance the traditional finance community retained toward employing academics largely came to an end.

Nowadays theoretical and practical innovation is the rule. Two of the more visible recent innovations are program trading—that is, doing extensive market price data analysis to find small price "discrepancies" and trading on them—and portfolio insurance. Bernstein discusses these developments in the second and third chapters in the section.

The chapter on portfolio insurance is the most interesting in the book. Bernstein's personal experience allows him to discuss the development of portfolio insurance from both a practitioner's and a theoretician's viewpoint. Portfolio insurance involves trading in both the actual assets and their futures in a specified manner to protect ("insure") the portfolio from large changes in value. The opening of futures markets for major stock indexes went a long way toward making portfolio insurance-type trading practical. The downside of such trading was the possibility of a disruption like the market crash of October 1987. Without assigning blame to portfolio insurance, Bernstein gives a thoughtful discussion of the resulting Brady Commission report. Whether or not it caused the crash, portfolio insurance certainly suffered because of that event. The breakdown in the relationship between equity market prices and futures market prices led portfolio insurance trading to fail under exactly the sort of conditions that many portfolio insurance clients had hoped to protect themselves against.

Conclusion

The final chapter contains an overview and conjectures about the future. Bernstein concludes that the revolution in finance, while dramatic, is not complete. Ever more efficient, competitive, and innovative markets will make everyone better off.

Bernstein does not discuss current developments affiliated with the ideas he has traced throughout the book. Efficient markets theory is being questioned from a number of different perspectives. New financial instruments (such as interest rate swaps and derivatives), all with unique and sometimes not well understood risk characteristics, are proliferating. Bernstein is probably wise, in a book about the origins of finance theory, to ignore current problems and developments that he had not explored earlier in the text. A conclusion with too many open-ended issues would have detracted from the historical tone the author established.

Overall, *Capital Ideas* is an interesting history of finance, but the subtitle, *The Improbable Origins of Modern Wall Street*, hints at more than the text delivers. Applying statistical techniques to financial data strikes me as more of a probable than improbable path of intellectual development. Acknowledging that the origins of financial theory are not startling does not, however, indicate that the recounting of the theory's development or implications is uninteresting. Quite the contrary, Bernstein has produced a readable and entertaining text. Finance professors who devised radically new trading strategies because "lifestyles were in danger and it was time for an invention" are bound to make interesting subjects.

My one quibble is that Bernstein perhaps tries to reach too broad an audience. It is unlikely that many, outside of academics and finance professionals, will be drawn to the subject. Within the finance community, however, many will find *Capital Ideas* interesting, but they may have benefited more from a technically oriented presentation.

Note

1. Interestingly, Fama has also done some work leading the questioning of the efficient markets hypothesis; see David N. DeJong and Charles H. Whiteman, "More Unsettling Evidence on the Perfect Markets Hypothesis," Federal Reserve Bank of Atlanta *Economic Review* 77 (November/December 1992): 1-13.

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